HIGH-END COMPUTING CAPABILITY PORTFOLIO

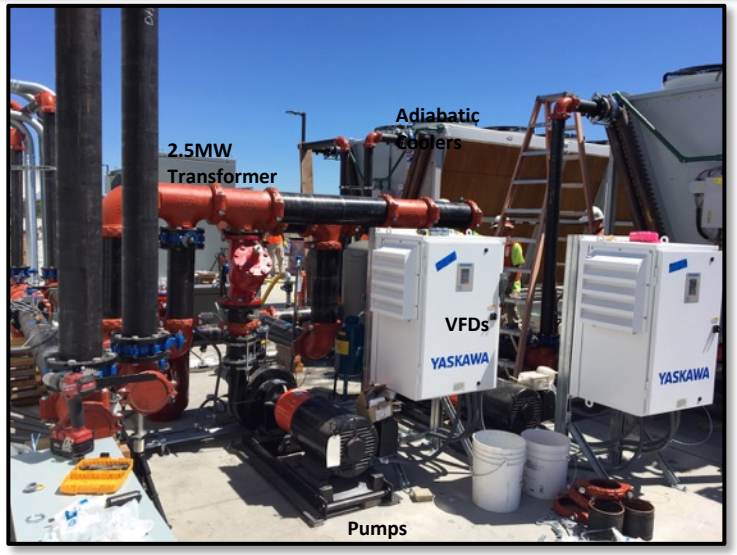
WILLIAM THIGPEN

August 10, 2019

First NFE Module Commissioned and Ready for Operation

- The first module installed for the NAS Facility Expansion (NFE) project was commissioned on July 24, 2019. The module is completely functional and ready for operation.
- During commissioning, the module's electrical system, cooling loop pumps and piping, fire suppression system, and controls system were all verified to operate per plan.
  - The controls system was manipulated to verify set point operations and proper measurement of key module parameters.
  - Redundancy of the pumps was verified by manual shutdown of the operating pump with the controls automatically starting up the redundant pump.
  - The fire suppression system was commissioned with the Ames Deputy Fire Marshal, the Ames Building Inspector, and Jacobs Fire Technicians. The fire system is in a 10-day burn in, where the alarm with notification to the Fire Department is active, but the Novec suppression system is inactive.
- Upon commissioning, the module and the E-Cells (delivered July 22, 2019) were powered up on July 26, and the HVAC, electrical, and controls worked as expected.

IMPACT: The NFE infrastructure enables deployment of four times the existing HECC resources to support NASA's future demand for supercomputing resources.



The support equipment being installed for the first module. This allows cooling of the compute within the module to be accomplished with ambient air. *Chris Tanner, NASA/Ames*

NFE Fiber-Optic Communications Link Installed

- Fiber was installed in the underground conduits between the NAS Facility Expansion (NFE) site, R&D-099, and the main NAS facility, Bldg. N258. The link provides disk storage capability in N258 for the compute racks installed in the NFE.
- The fiber-optic cable was installed over a two-week period by staff in the NASA Ames IT Operations Division.
  - The 288-strand Single Mode Fiber cable is approximately 600 meters long.
  - Each end of the fiber is fusion splice terminated, and landed in rack mounted patch panels.
  - Conduit was installed in the N258 underfloor areas and building plenums to safely distribute the cable to the communications rack located on the main computer floor.
- Three additional 288-strand fiber cables will be installed between the NFE and N258 in the future to support augmentation of the NFE.

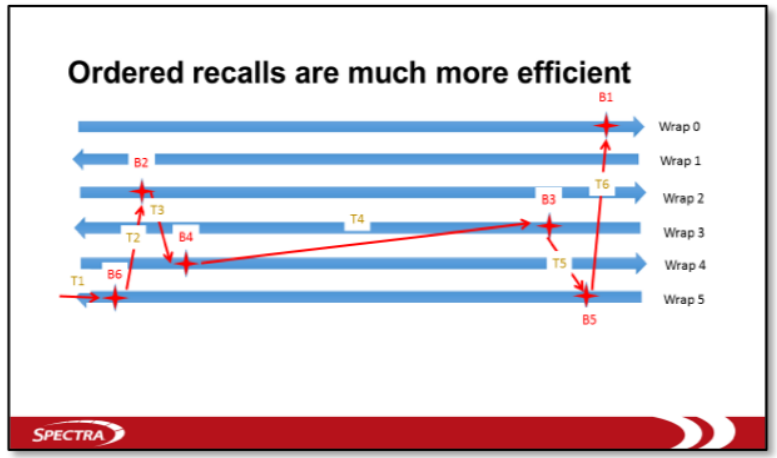
IMPACT: The fiber-optic cable linking the NAS Facility Expansion to the main NAS Facility is a cost- effective approach to providing storage for the NFE compute racks.

Patch panel installed in the new NAS facility communications rack for linking to the NAS Facility Expansion site.
Chris Tanner, NASA/Ames

New Tape Library Feature Improves Small File Recall Performance

- HECC engineers recently tested new functionality to improve access time to small files on the tape library infrastructure. The tape library vendor, Spectra Logic, developed a feature called “Time-Based Access Ordering System” (TAOS) that optimizes tape read requests to be more efficient.
- During testing, we measured a 4-times improvement in access time when reading a set of small files that were interspersed with large files on tape.
- TAOS will be deployed on the production archive system by the end of August.
- This new functionality is provided at no-cost with the library, and supports LTO-7 and LTO-8 tape drives. TAOS also reduces the wear on tape media and tape drives, which improves the overall system reliability.

IMPACT: Improved access time to archive data enables users to spend less time retrieving data and more time on simulation and analysis for NASA projects.

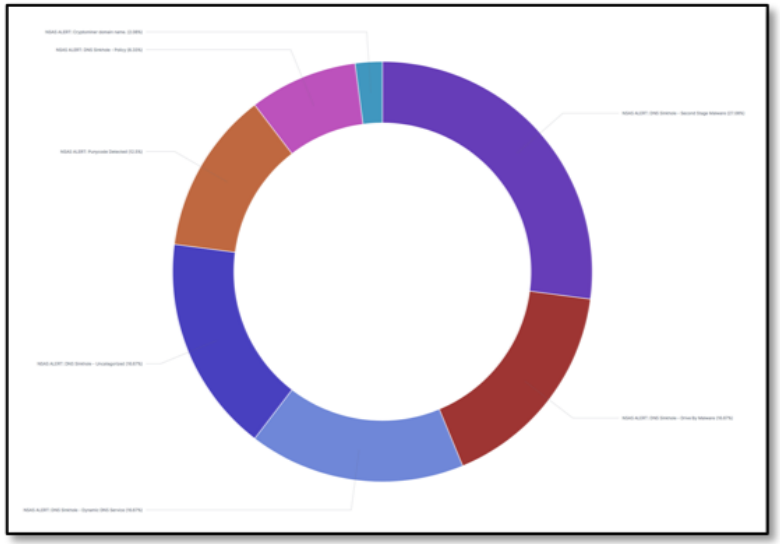


Data is normally accessed in the order it was requested. TAOS re-orders the sequence to the most efficient order to access the data. This reduces the amount of tape seeks and rewinds to the data. *Graphic courtesy of Spectra Logic*

DNS Analytics Improves Cybersecurity Operations

- The Security Group upgraded the Domain Name System (DNS) server analytics to improve HECC's security monitoring system.
- DNS, a critical component of the Internet and one of the few applications allowed to cross network perimeters, is a highly attractive channel for advanced threat actors.
- DNS analytics improves cybersecurity operations by detecting:
  - DNS hijacking of NAS and NASA domains.
  - Command and control traffic utilizing long domain names.
  - Malicious domains.
  - Homograph attacks.
  - Infections due to suspicious DNS lookups.
- Security staff continue to improve DNS analytics; future work will include adding detection for data exfiltration and forensic markers.

IMPACT: HECC DNS analytics provide actionable threat intelligence and additional indicators of suspicious activity that reduces the complexity of cybersecurity operations.



Pie chart showing the breakdown of HECC DNS alerts in a 24-hour period.

HECC Team Showcases NASA Supercomputing at the Highly Successful Apollo 50 Festival on the National Mall

- HECC took the stage at the Apollo 50 Festival, held July 18–20 in Washington, D.C. to celebrate the 50th anniversary of the first Moon landing and kick off the Artemis Program to return humans to the Moon in 2024.
  - The HECC exhibit was a key part of the Technology Drives Exploration booth, one of 20 NASA booths at the event, sponsored by NASA and the Smithsonian Air and Space Museum.
- The team greeted thousands of attendees excited to talk to experts about the role of supercomputing across the agency's missions.
  - Aerospace engineer Derek Dalle, NASA Advanced Supercomputing Division, showed visualizations and described the impact of HECC-enabled modeling and simulation on development of the Space Launch System, the Orion Launch Abort System, and the X-57 experimental electric aircraft.
  - HECC Control Room analyst Evan Dodge demonstrated distributed computing via an innovative, interactive demo: a compute cluster comprised of eight Raspberry Pi processors running a simple hydrodynamics program. His instruction manual for building the cluster was downloaded more than 7,000 times from the HECC website during and after the event (see slide 8).
- An Air & Space Museum public affairs coordinator said the event, which drew 50,000 despite record heat, "surpassed all of our expectations."

IMPACT: This high-profile, national public outreach event was a great opportunity to highlight the critical role of HECC resources in NASA missions.

Aerospace engineer Derek Dalle demonstrates distributed computing to a family attending the Apollo 50 Festival.
Michelle Moyer, NASA/Ames

Raspberry Pi Cluster Tutorial Reaches 8,300+ Downloads

- Since the first interactive demonstration of the Raspberry Pi cluster (see the HECC status report dated June 10, 2019), a related tutorial has been downloaded more than 8,300 times. Initially created by Control Room (CR) analysts for self-led exercises to train new CR staff, the analysts developed a scaled down version of their internal educational exercises and released the tutorial to the public.
- The system consists of eight Raspberry Pi nodes, a PBS scheduler, message passing interface, and hydrodynamics program used to demonstrate distributed computing.
  - The tutorial was downloaded more than 7,250 times in July 2019, after the demo was presented in the HECC exhibit at the Apollo 50 Festival on the National Mall in Washington, D.C. (see slide 7).
  - After the Raspberry Pi cluster was shown to interns at Ames Research Center in June 2019, the tutorial was downloaded about 400 times.
  - The tutorial was downloaded more than 660 times following a demonstration at the Bay Area Maker Faire in May 2019.
- Several teachers and educators have taken an interest in this project and asked for video tutorials for students. HECC staff are currently researching this effort.

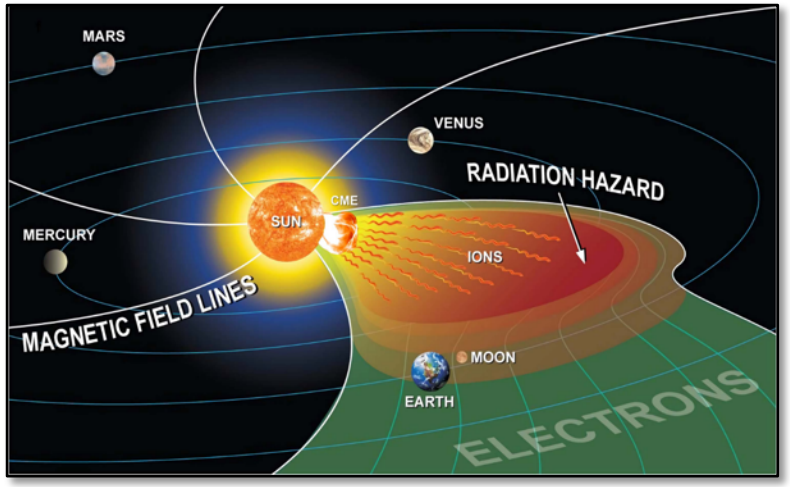
IMPACT: Innovative projects such as the Raspberry Pi cluster provide an excellent tool for NASA outreach opportunities and staff training.

The Raspberry Pi Cluster QR Code distributed to the public.
John Hardman, NASA/Ames

Forecasting Solar Particle Threats Through Simulation*

- Researchers at Predictive Science Inc. are running simulations on Pleiades of coronal mass ejections (CMEs) and solar flares that can produce large solar particle events (SPEs).
- SPEs pose significant technological hazard to aircraft avionics, communications, and navigation, are a possible health risk for airline crews and passengers, and can be hazardous for crews of spacecraft in low-Earth orbit, the International Space Station, and future interplanetary missions.
  - To help face this challenge, the researchers developed the SPE Threat Assessment Tool (STAT) to model CME-generated events. STAT combines state-of-the-art magnetohydrodynamic computations with a cutting-edge solar energetic particle model to predict SPE fluxes.
  - Future development will allow the particle simulations to follow the CME as it travels out to Earth and beyond. Advancements in real-time CME simulations will be leveraged to eventually transition STAT into an operational forecasting tool for SPE hazards.
- STAT will be hosted at NASA's Community Coordinated Modeling Center, allowing researchers to quickly generate and run SPE simulations and receive clearly summarized visualizations and data results.

IMPACT: The ability to run multiple SPE simulations and compare the results with observations will advance knowledge about such events and their behavior and help develop predictive capabilities.



Schematic of a solar particle event caused by a coronal mass ejection. The accelerated ions pose technological and human hazards in space. *Arik Posner, NASA/HQ*

** HECC provided supercomputing resources and services in support of this work.*

HECC Facility Tours in July 2019

- HECC hosted 11 tour groups in July; guests learned about the agency-wide missions being supported by HECC assets, and also viewed the D-Wave 2000Q quantum system. Visitors this month included:
  - George Scott, NASA's Deputy Inspector General, and Leslie McClendon, NASA's Investigative Counsel, visited the facility for an overview and tour.
  - Katie Bouman, Assistant Professor in the Computing and Mathematical Sciences Department at Caltech, and Yonatan Winetraub, Co-Founder of SpaceIL; both were here at Ames as guest speakers for the Summer Series Colloquia.
  - Six large groups of summer interns visited this month; interns were from the Ames Internship Program, NASA's Stratospheric Observatory for Infrared Astronomy, SLAC National Accelerator Laboratory, NASA Earth Exchange, Lockheed, Millennium Space Systems, and Japan Aerospace Exploration Agency, as well as NAS Division interns.

Piyush Mehrotra (center) NASA Advanced Supercomputing (NAS) Division Chief, presents to a delegation from the Japan Aerospace Exploration Agency. *Gina Morello, NASA/Ames*

Papers

- "**Multi-Filament Gas Inflows Fuelling Young Star-Forming Galaxies**," D. C. Martin, et al., Nature Astronomy – Letters, July 1, 2019. *
  https://www.nature.com/articles/s41550-019-0791-2
- "**Wavelet-Based Adaptive Delayed Detached Eddy Simulations For Wall-Bounded Compressible Turbulent Flows**," X. Ge, O. Vasilyev, M. Y. Hussaini, Journal of Fluid Mechanics, vol. 873, published online July 1, 2019. *
  https://doi.org/10.1017/jfm.2019.449
- "**Relativistic Electrons Generated at Earth's Quasi-Parallel Bow Shock**," T. Liu, V. Angelopoulos, S. Lu, Science Advances, vol. 5, no. 7, July 3, 2019. *
  https://advances.sciencemag.org/content/5/7/eaaw1368.abstract
- "**Determining Star Formation Thresholds from Observations**," S. Khullar, M. Krumholz, C. Federrath, A. Cunningham, Monthly Notices of the Royal Astronomical Society, vol. 488, issue 1, published online July 3, 2019. *
  https://academic.oup.com/mnras/article/488/1/1407/5527936
- "**Marine Ice Sheet Instability Amplifies and Skews Uncertainty in Projections of Future Sea-Level Rise**," A. Robel, et al., Proceedings of the National Academy of Sciences of the United States of America (PNAS), July 8, 2019. *
  https://www.pnas.org/content/116/30/14887.short
- "**How Dense a CSM is Sufficient to Choke a Jet?**" P. Duffell, A. Ho, arXiv:1907.03768 [astro-ph.HE], July 8, 2019. *
  https://arxiv.org/abs/1907.03768

** HECC provided supercomputing resources and services in support of this work*

Papers (cont.)

- "**Can the Superposition of Evaporative Flows Explain Broad Fe XXI Profiles During Solar Flares?**" V. Polito, P. Testa, B. De Pontieu, The Astrophysical Journal Letters, vol. 879, no. 2, July 8, 2019. *
  https://iopscience.iop.org/article/10.3847/2041-8213/ab290b/meta
- "**SO_2 Emission Estimates Using OMI SO_2 Retrievals for 2005–2017**," Z. Qu, et al., Journal of Geophysical Research: Atmospheres, published online July 9, 2019. *
  https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2019JD030243
- "**Hybrid Mass Balance/4D-Var Joint Inversion of NO_X and SO_2 Emissions in East Asia**," Z. Qu, et al., Journal of Geophysical Research: Atmospheres, published online July 9, 2019. *
  https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2018JD030240
- "**Planetesimals Around Stars with TESS (PAST): I. Transient Dimming of a Binary Solar Analog at the End of the Planet Accretion Era**," E. Gaidos, et al., Monthly Notices of the Royal Astronomical Society, published online July 12, 2019. *
  https://academic.oup.com/mnras/advance-article/doi/10.1093/mnras/stz1942/5531782
- "**Dynamic Aeroelasticity of Wings with Tip Propeller by Using Navier-Stokes Equations**," G. Guruswamy, AIAA Journal, published online July 12, 2019. *
  https://arc.aiaa.org/doi/full/10.2514/1.J058610
- "**Space Technology Drivers of Changes**," S. Madry, Disruptive Space Technologies and Innovations, July 14, 2019. *
  https://link.springer.com/chapter/10.1007/978-3-030-22188-1_5

** HECC provided supercomputing resources and services in support of this work*

Papers (cont.)

- "**Polyanion Electrolytes with Well-Ordered Ionic Layers in Simulations and Experiment**," L. Abbott, et al., Macromolecules (American Chemical Society), July 16, 2019. *
  https://pubs.acs.org/doi/abs/10.1021/acs.macromol.9b00416
- "**Role of Planetary Obliquity in Regulating Atmospheric Escape G-Dwarf vs. M-Dwarf Earth-Like Exoplanets**," C. Dong, Z. Huang, M. Lingam, arXiv:1907.07459 [astro-ph.EP], July 17, 2019. *
  https://arxiv.org/abs/1907.07459
- "**Advanced Astrophysics Discovery Technology in the Era of Data Driven Astronomy**," R. Barry, et al., arXiv:1907.10558 [astro-ph.IM], July 24, 2019. *
  https://arxiv.org/abs/1907.10558
- "**A Super-Earth and Two Sub-Neptunes Transiting the Nearby and Quiet M Dwarf TOI-270**," M. Günther, et al., Nature Astronomy – Letters, published online July 29, 2019. *
  https://www.nature.com/articles/s41550-019-0845-5

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News and Events

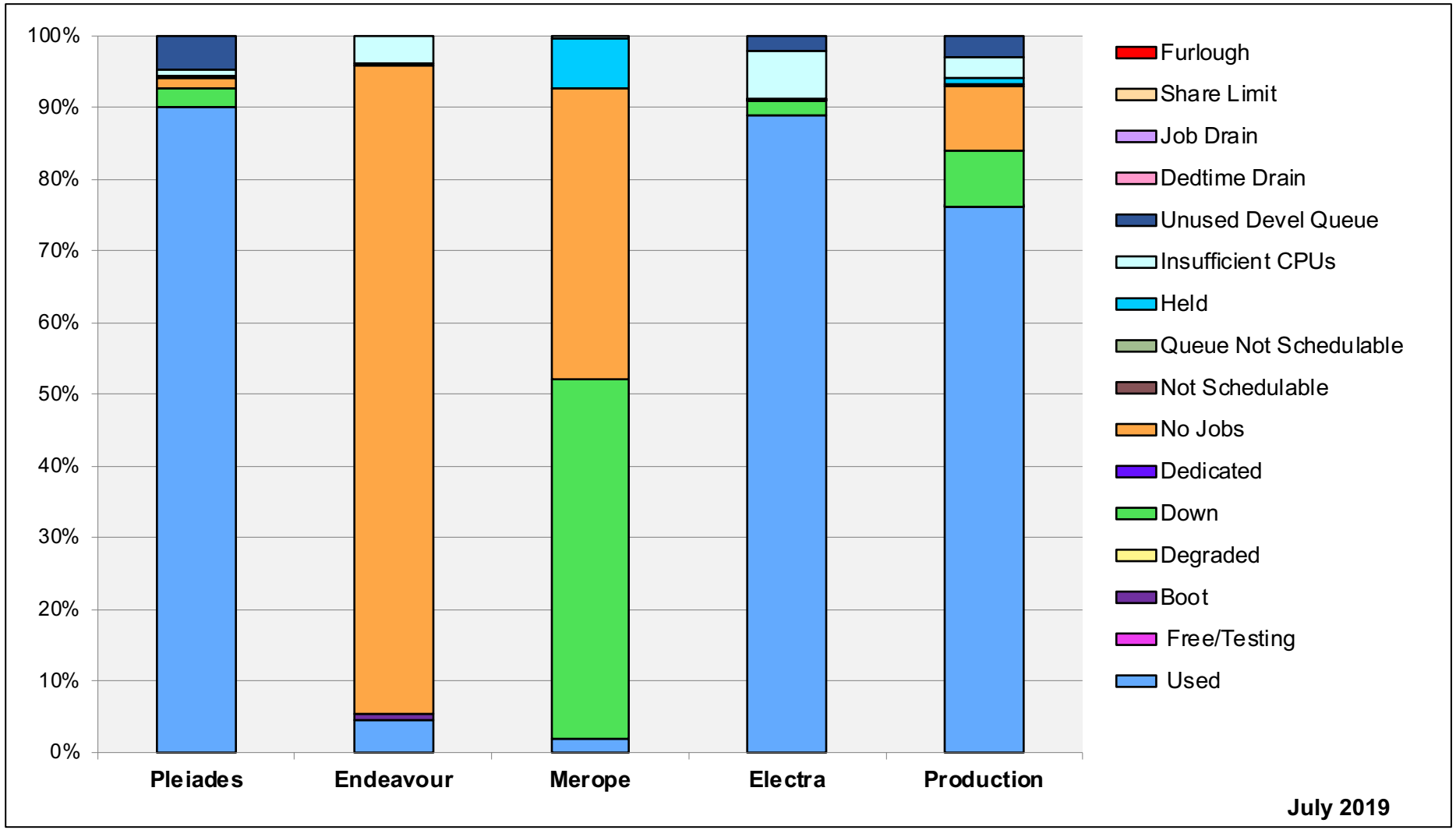
- **How Scientists Used Data to Predict Appearance of July 2 Eclipse**, *NASA Feature*, July 3, 2019—Using data from NASA's Solar Dynamics Observatory, Predictive Science Inc. ran a model over roughly two days on the Pleiades supercomputer at the NAS facility, in order predict how the magnetic field shapes the corona over time.
  https://www.nasa.gov/feature/how-scientists-used-nasa-data-to-predict-appearance-of-july-2-eclipse
  - **Coronal Prediction for the July 2, 2019 Total Solar Eclipse**, Predictive Science Inc. Final Prediction.
    http://www.predsci.com/corona/jul2019eclipse/home.php
- **Apollo 50th Anniversary Festival**, Washington D.C., July 18-20, 2019—Staff from the NASA Advanced Supercomputing (NAS) Division participated in the agency-wide festival on the National Mall celebrating the anniversary of the Apollo 11 moon landing (see slide 7).
  https://airandspace.si.edu/apollo-50-festival
  - **Weekend of Apollo 11's 50th Anniversary Opens on the National Mall**, *In Space News*, July 19, 2019.
    https://inspacenews.com/weekend-of-apollo-11s-50th-anniversary-opens-on-the-mall/

News and Events: Social Media

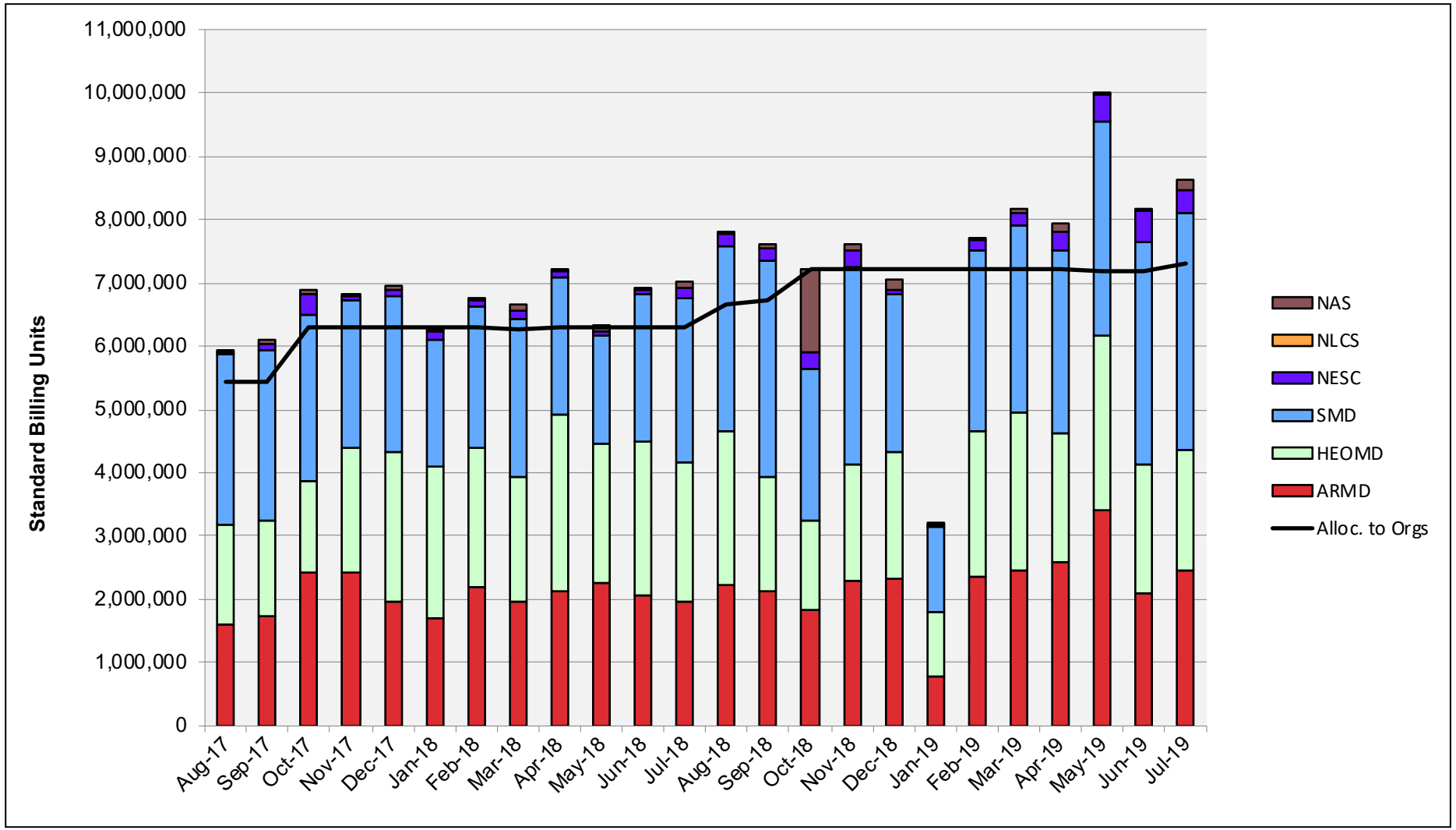
Top Posts from NAS

- Orion Launch Abort Test (simulation tie-in):
  - Twitter: 1 retweets, 6 likes
  - Twitter: 31 retweet, 141 likes
  - Facebook: 209 users reached, 27 engagements
- Fourth of July:
  - Twitter: 17 retweets, 121 likes
  - Facebook: 280 users reached, 16 engagements
- Apollo 50th Anniversary Festival participation:
  - Twitter: 2 retweets, 4 likes
  - Twitter: 3 retweets, 8 likes
  - Twitter: 5 retweets, 10 likes
  - Facebook: 384 users reached, 33 engagements

HECC Utilization



HECC Utilization Normalized to 30-Day Month



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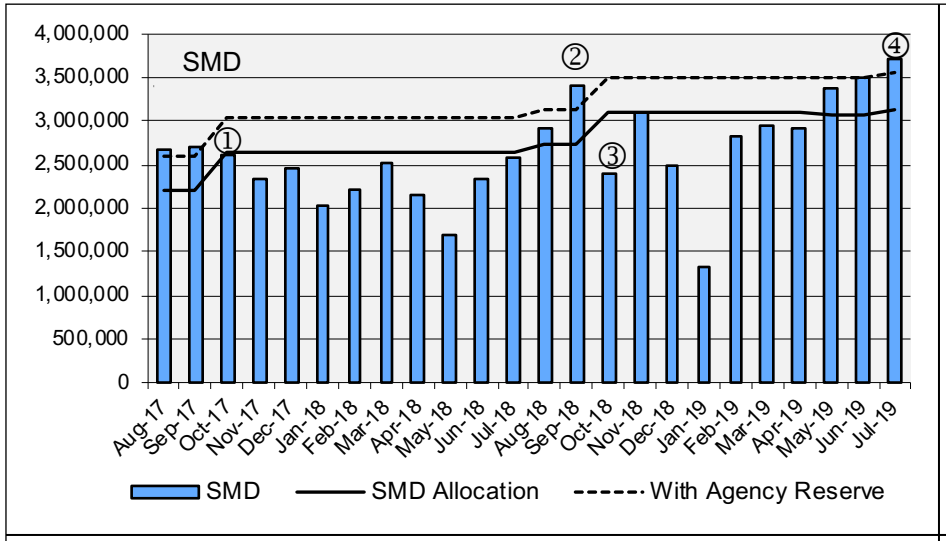
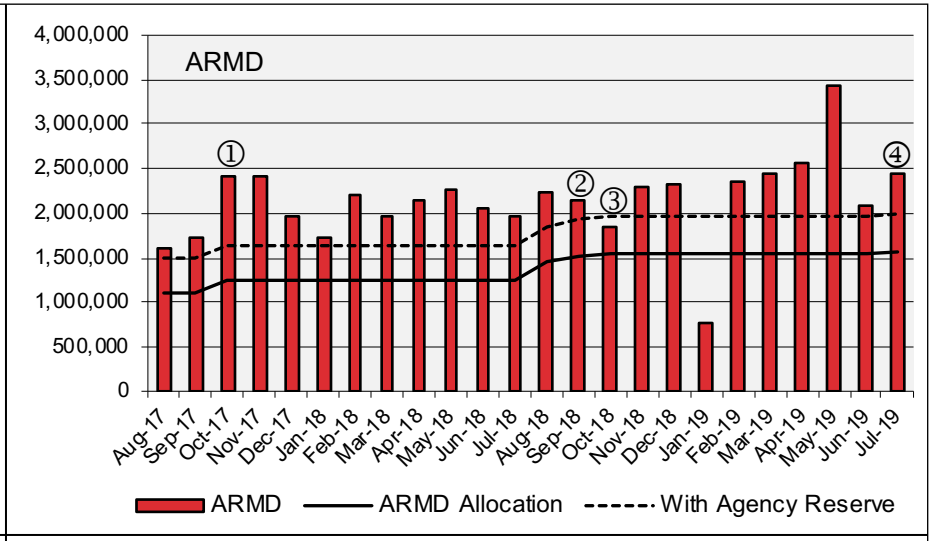
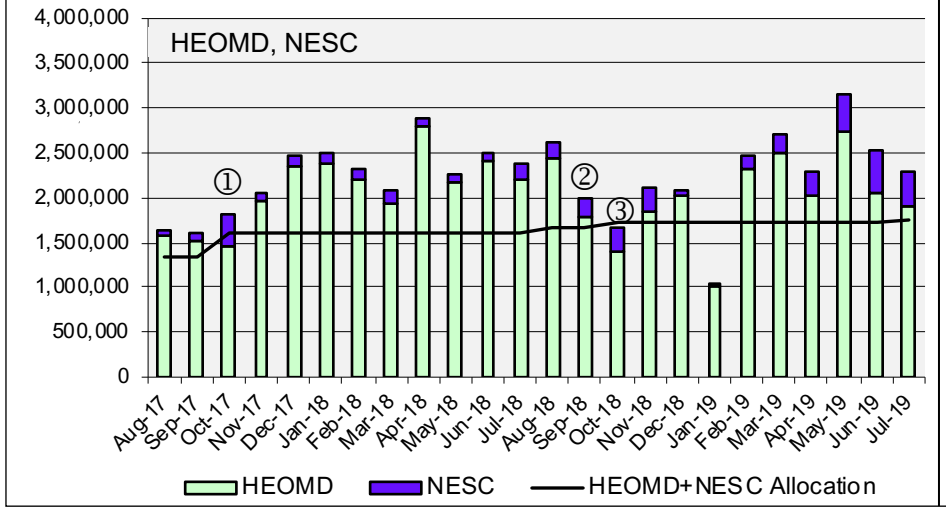






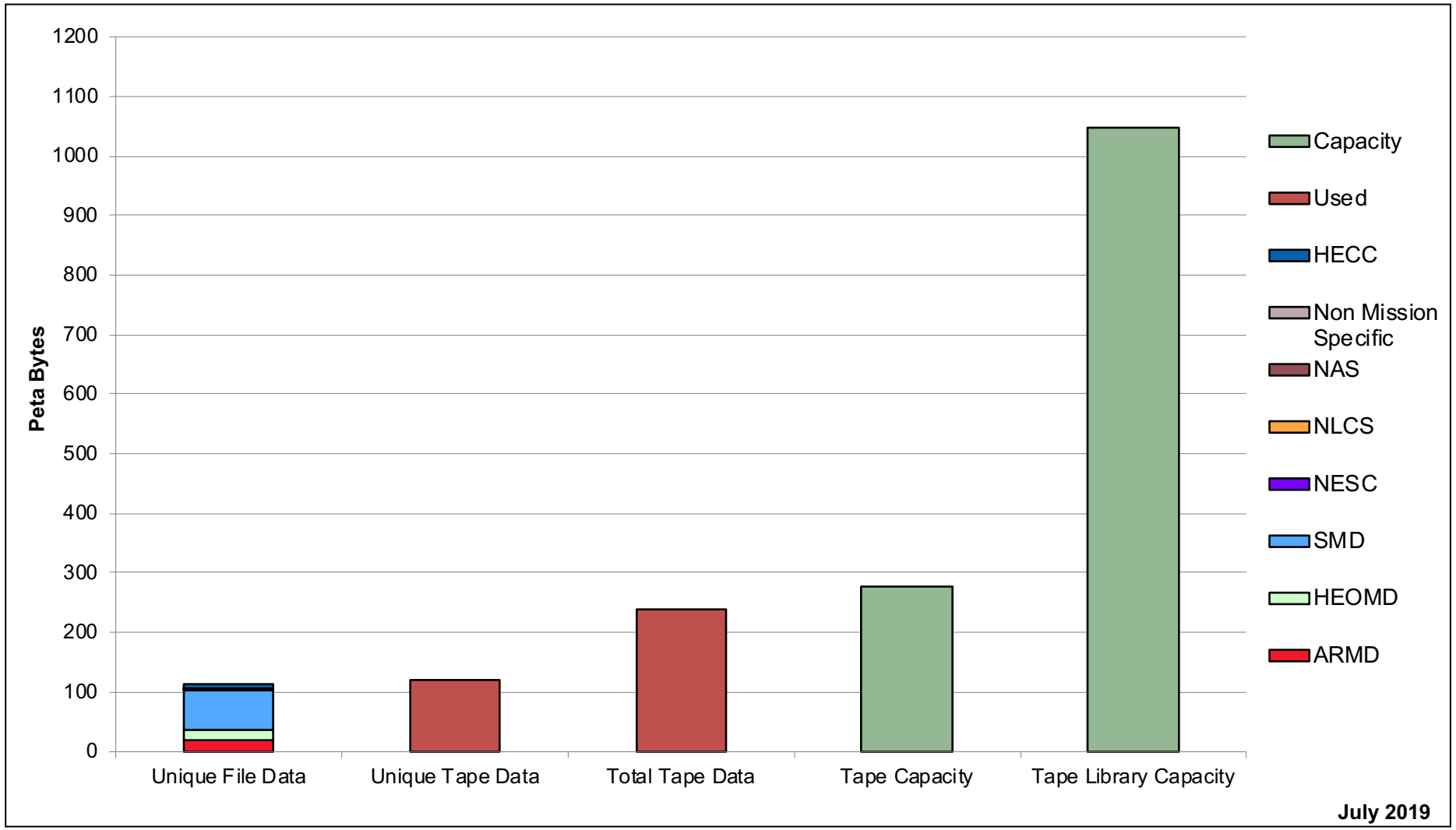
① 4 Skylake E cells (16 D Rack Equivalence) added to Electra

② 2 Skylake E cells (8 D Rack Equivalence) added to Electra; 1 rack is dedicated to ARMD

③ 2 Skylake E cells (8 D Rack Equivalence) added to Electra; 1 rack is dedicated to SMD

④ Skylake Tesla GPU V100 Nodes installed

Tape Archive Status



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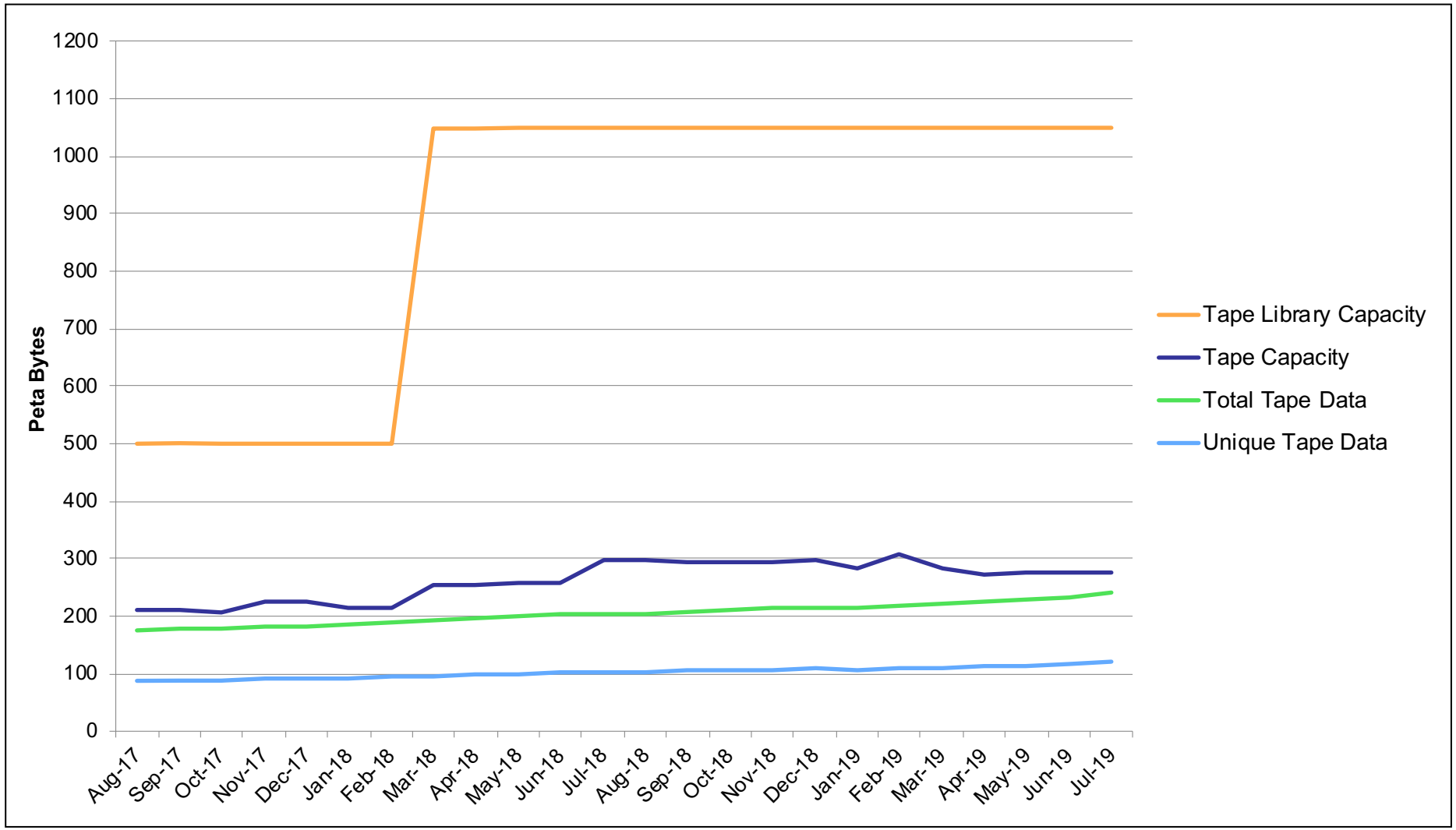
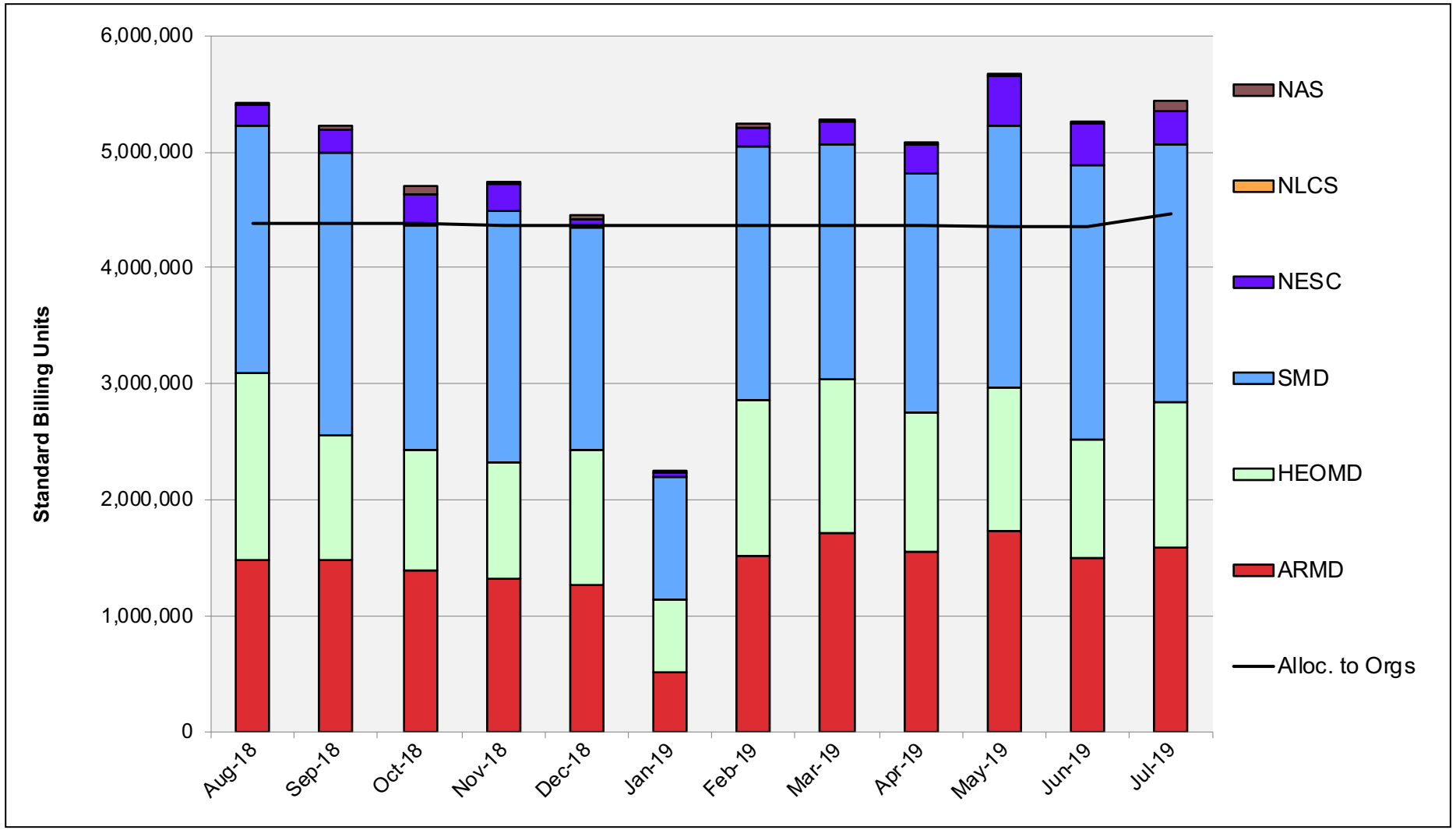
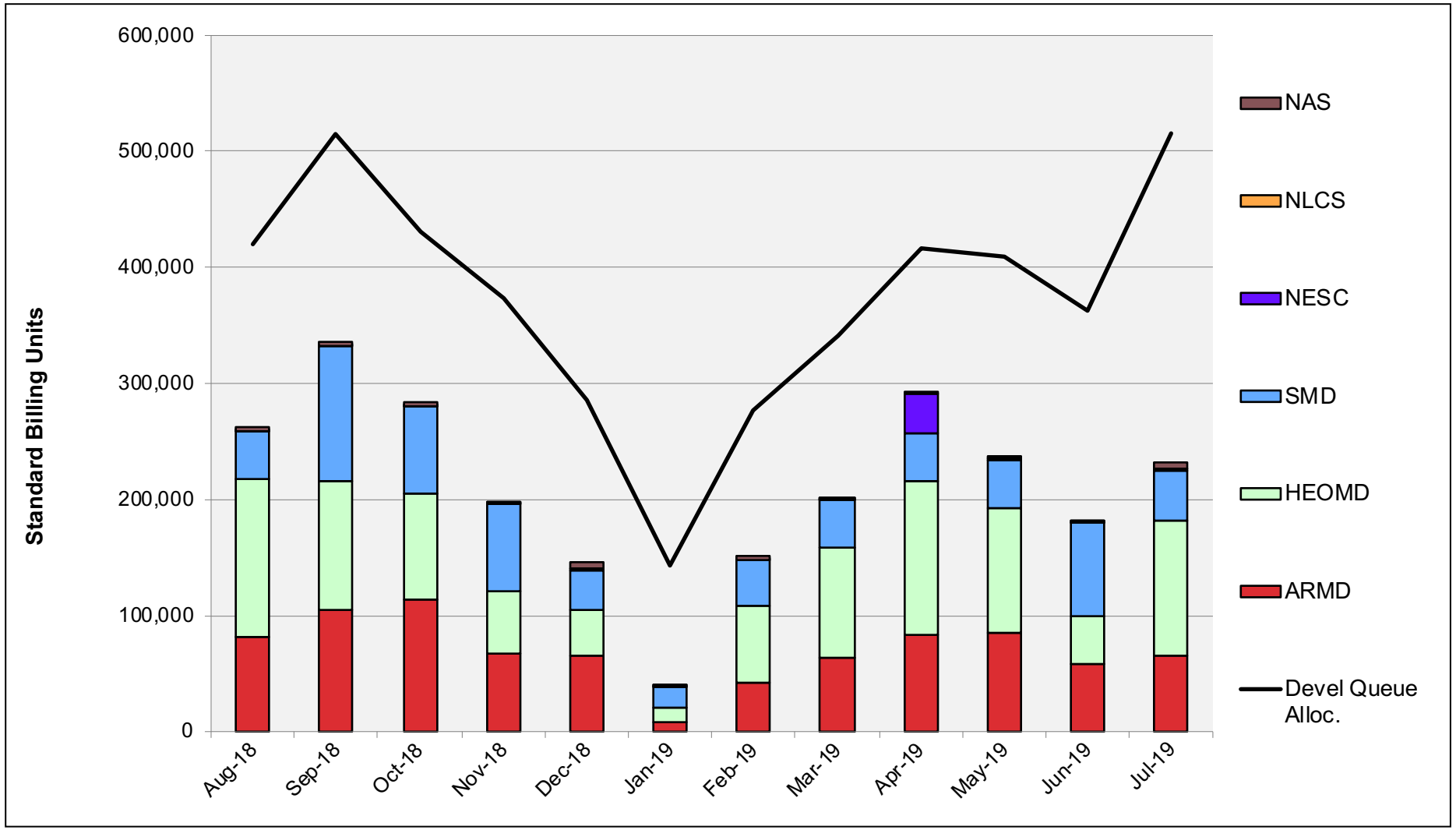


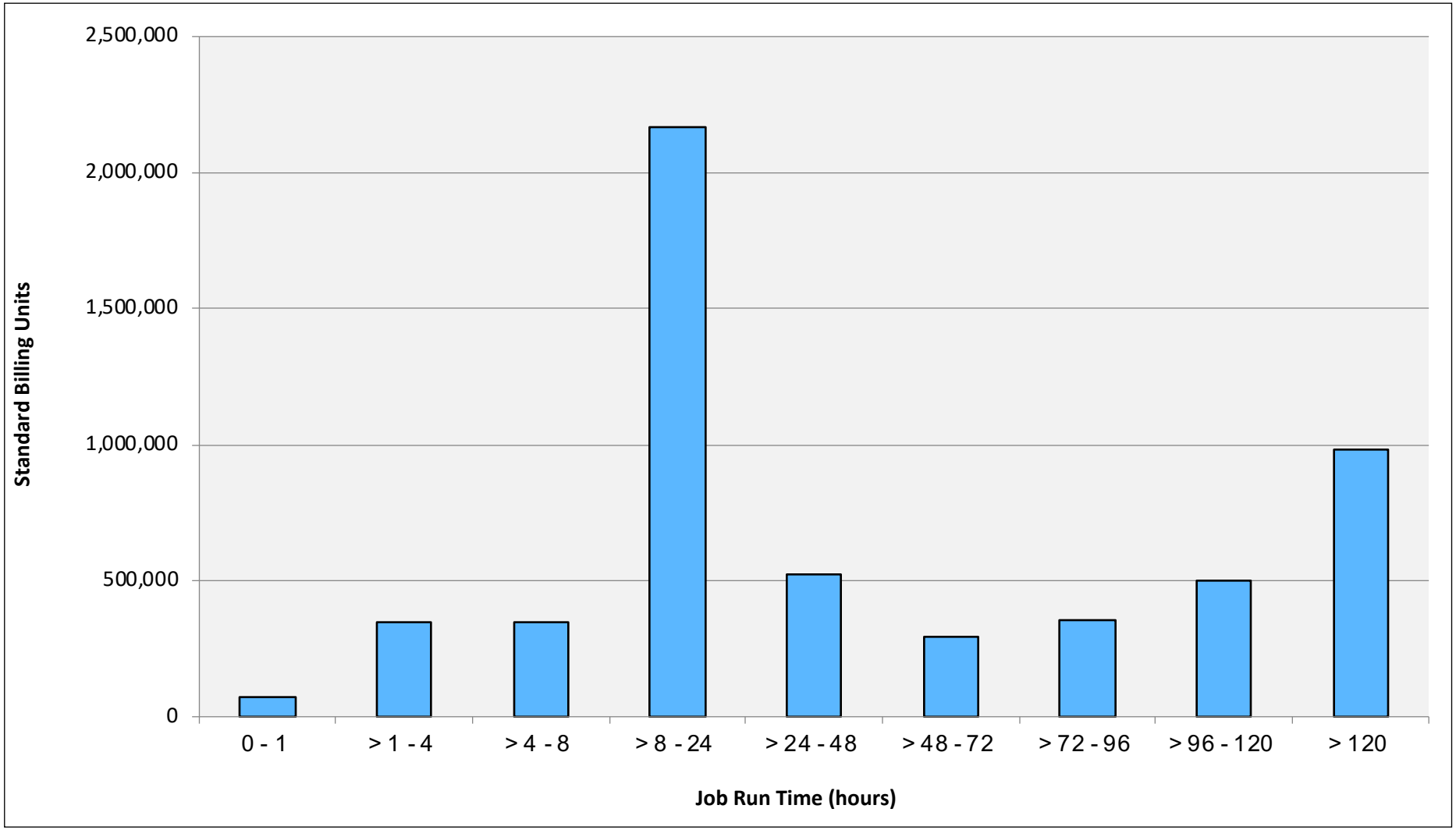
Pleiades: SBUs Reported, Normalized to 30-Day Month



Pleiades: Devel Queue Utilization



Pleiades: Monthly Utilization by Job Length



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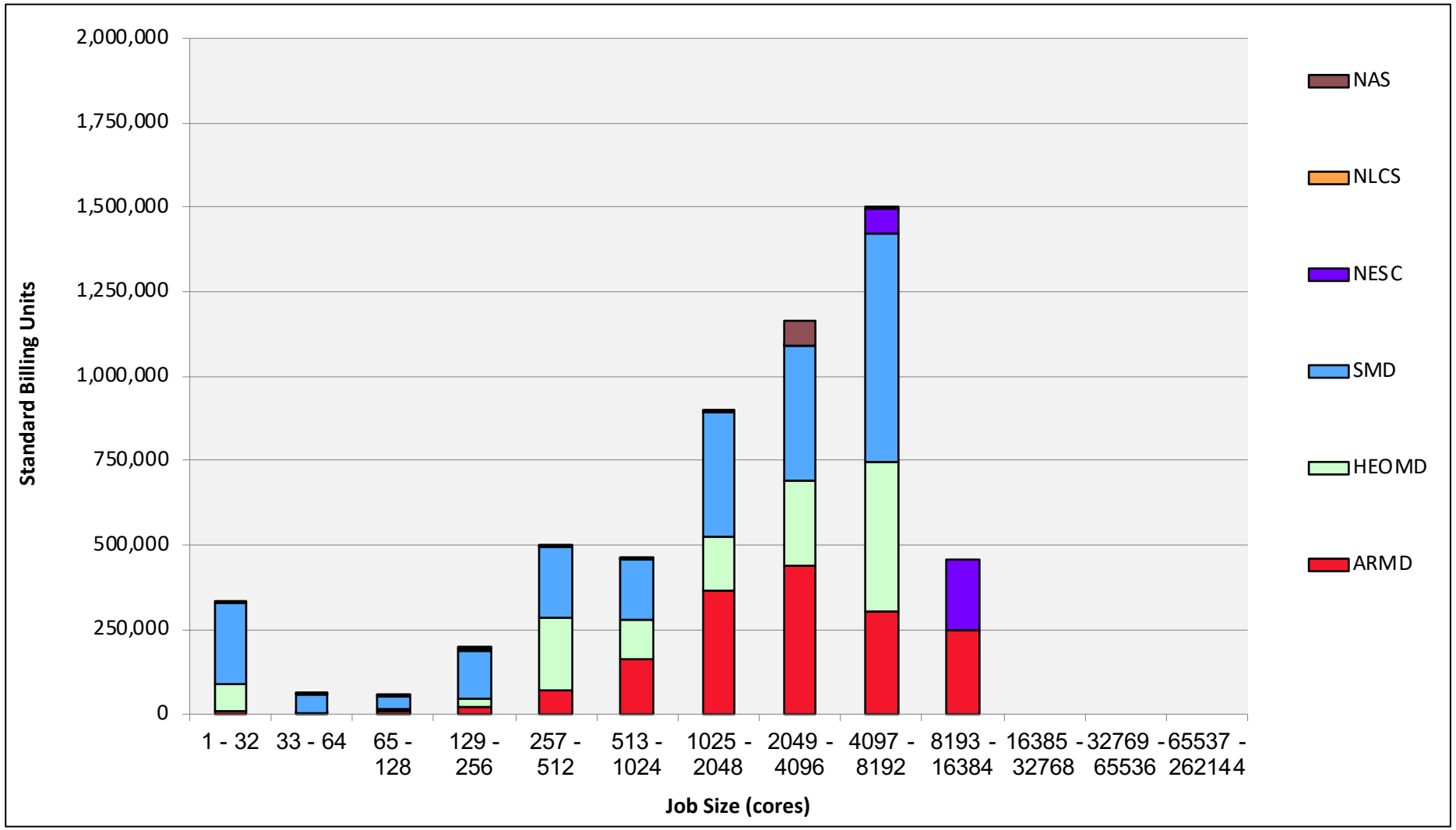
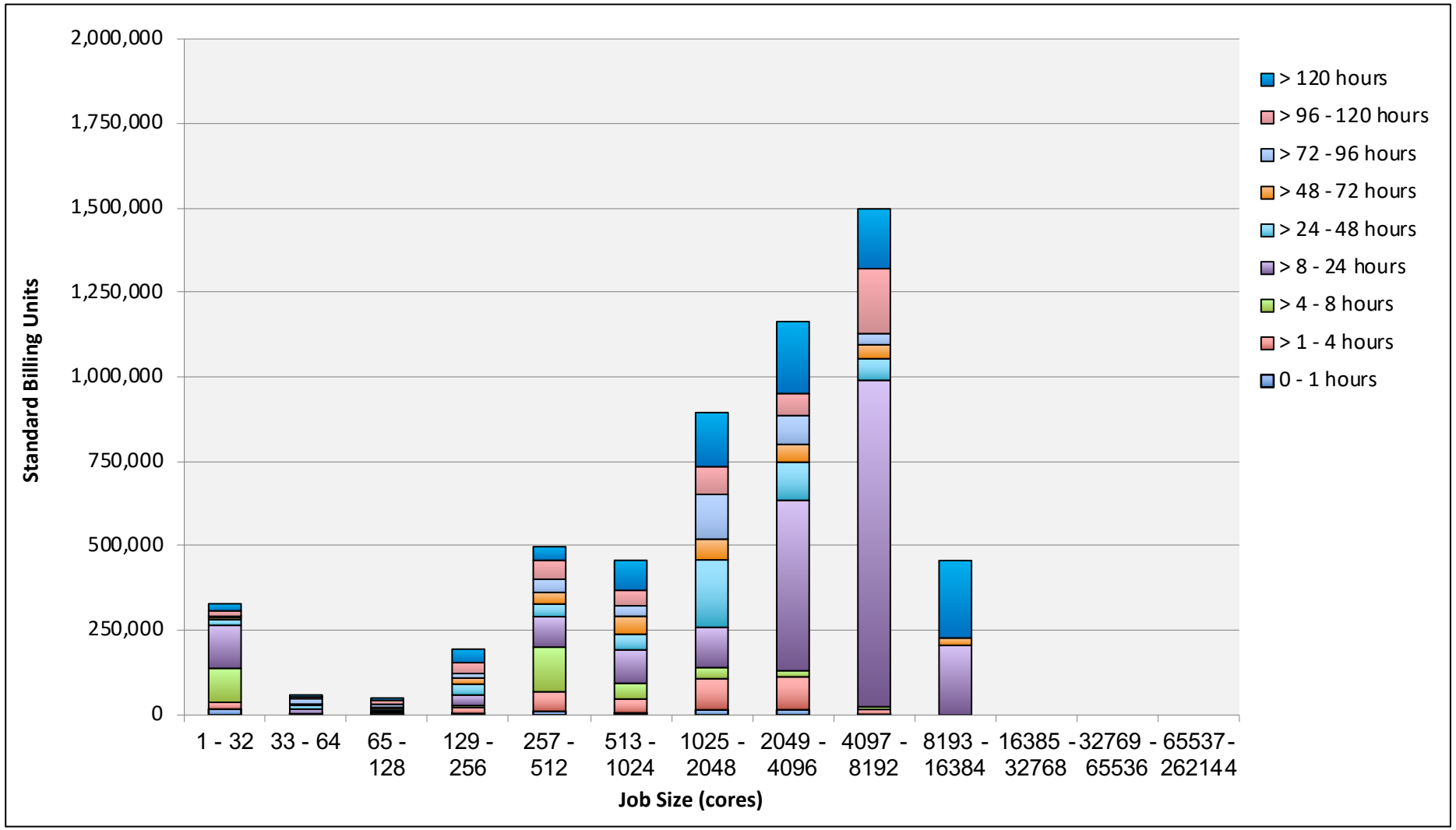
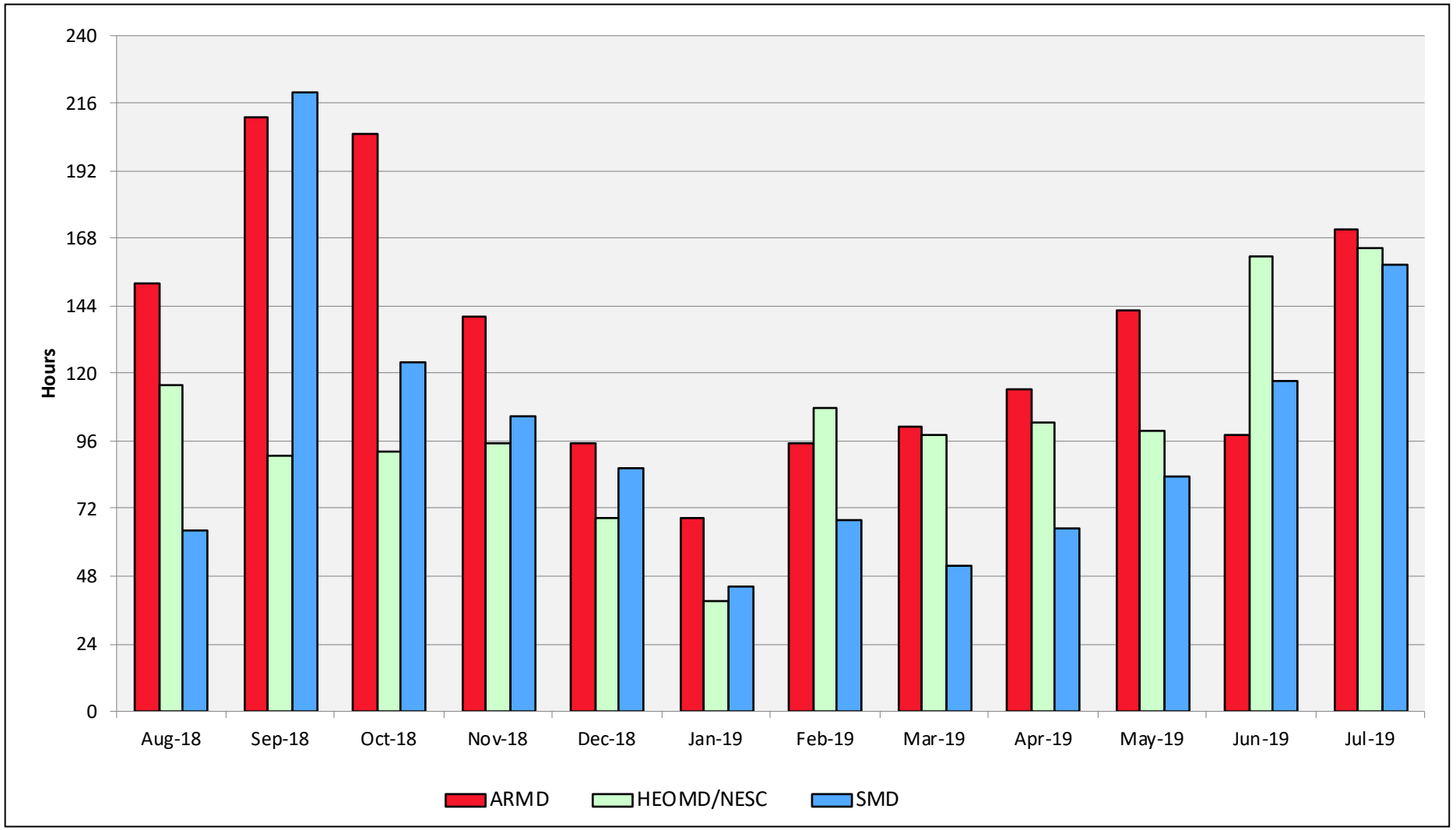


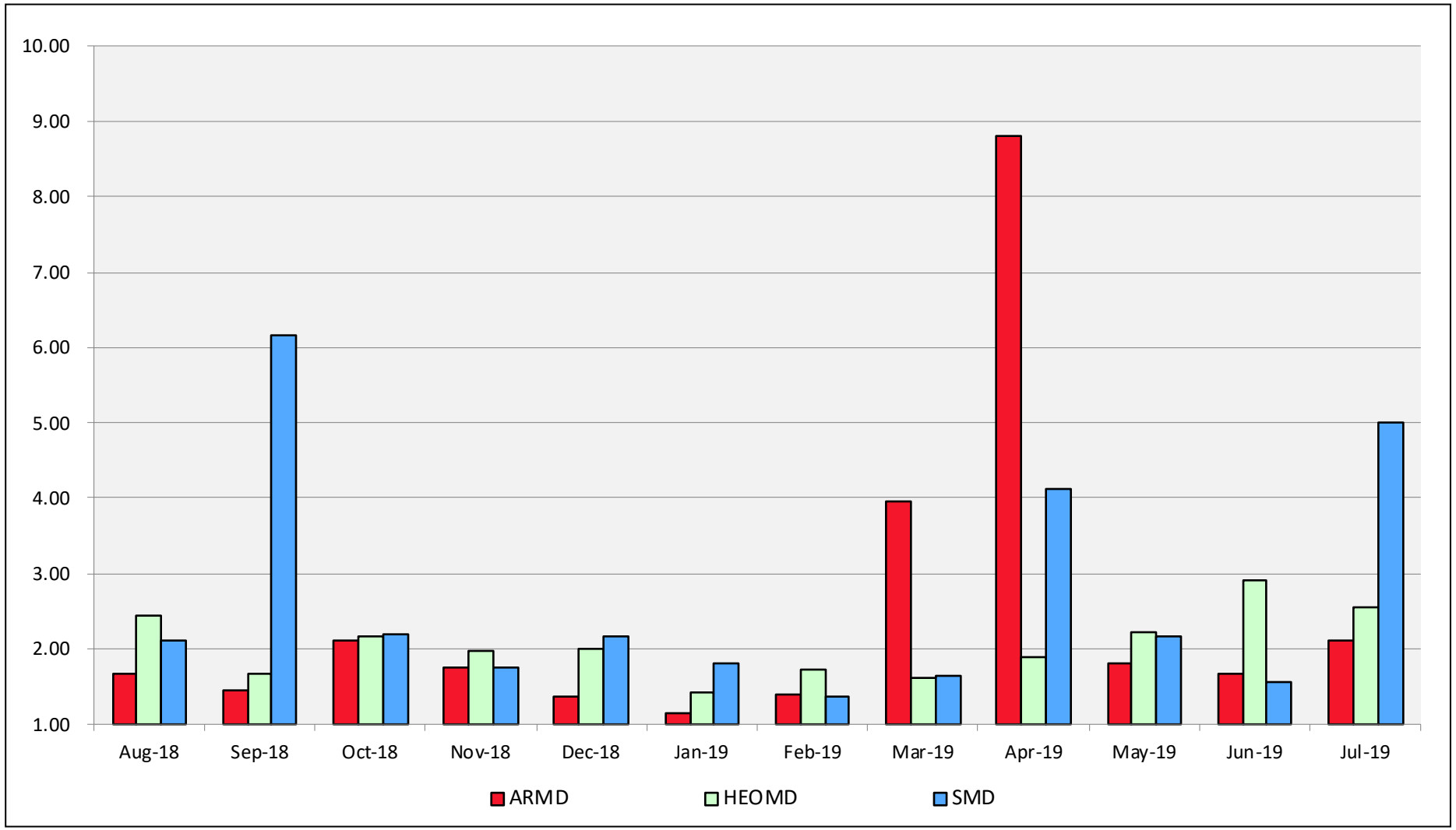
Pleiades: Monthly Utilization by Size and Length



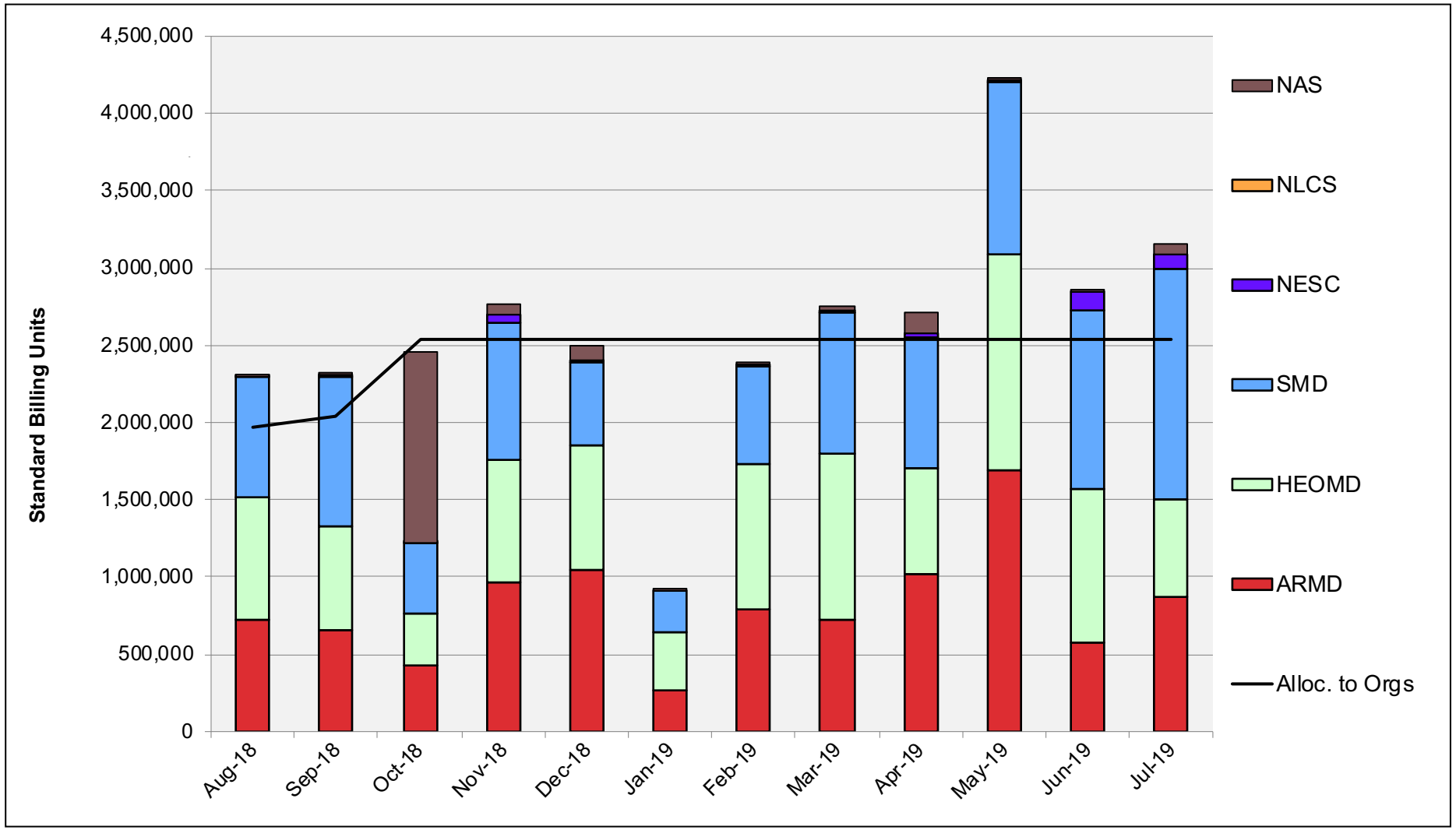
Pleiades: Average Time to Clear All Jobs



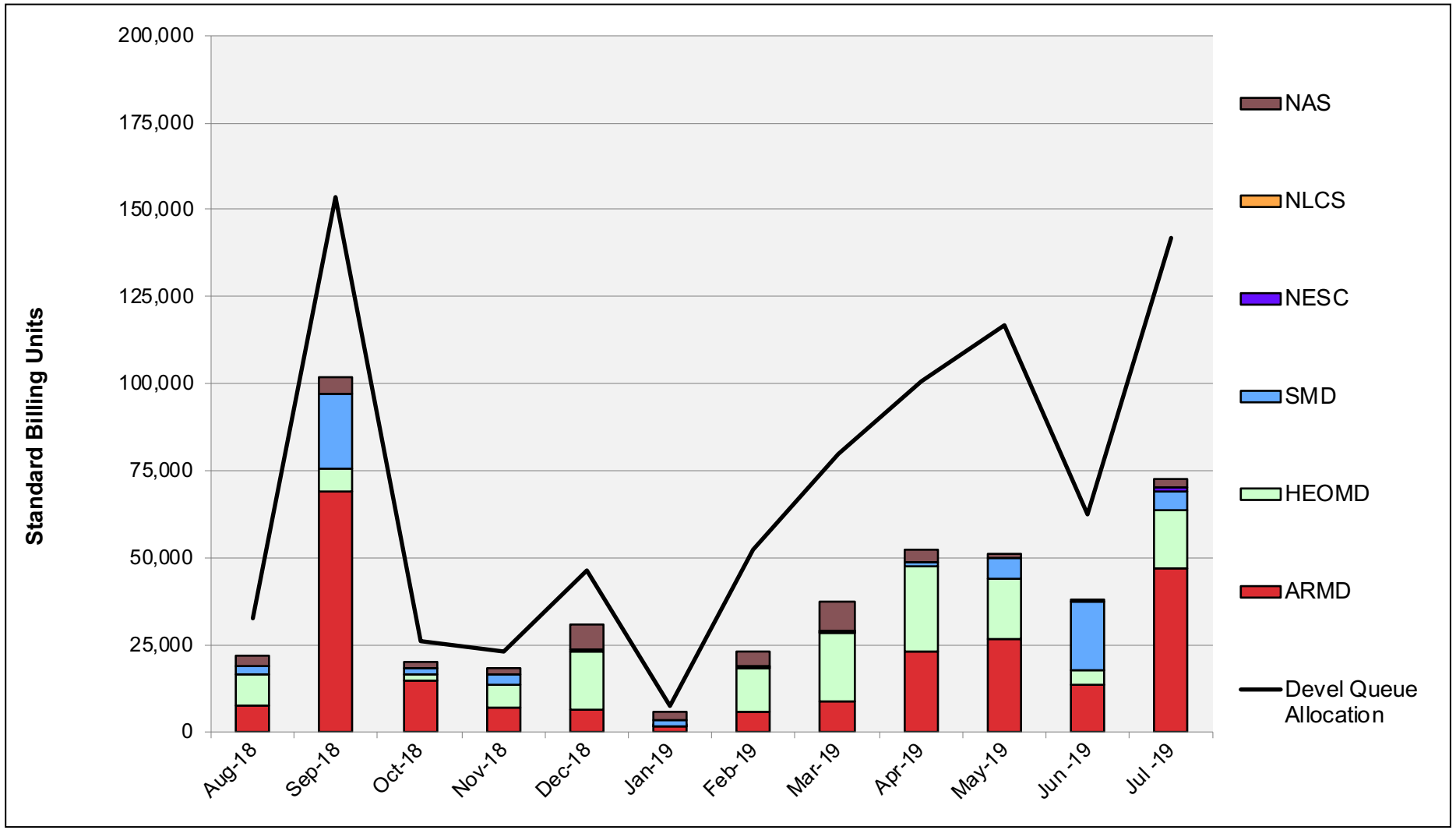
Pleiades: Average Expansion Factor



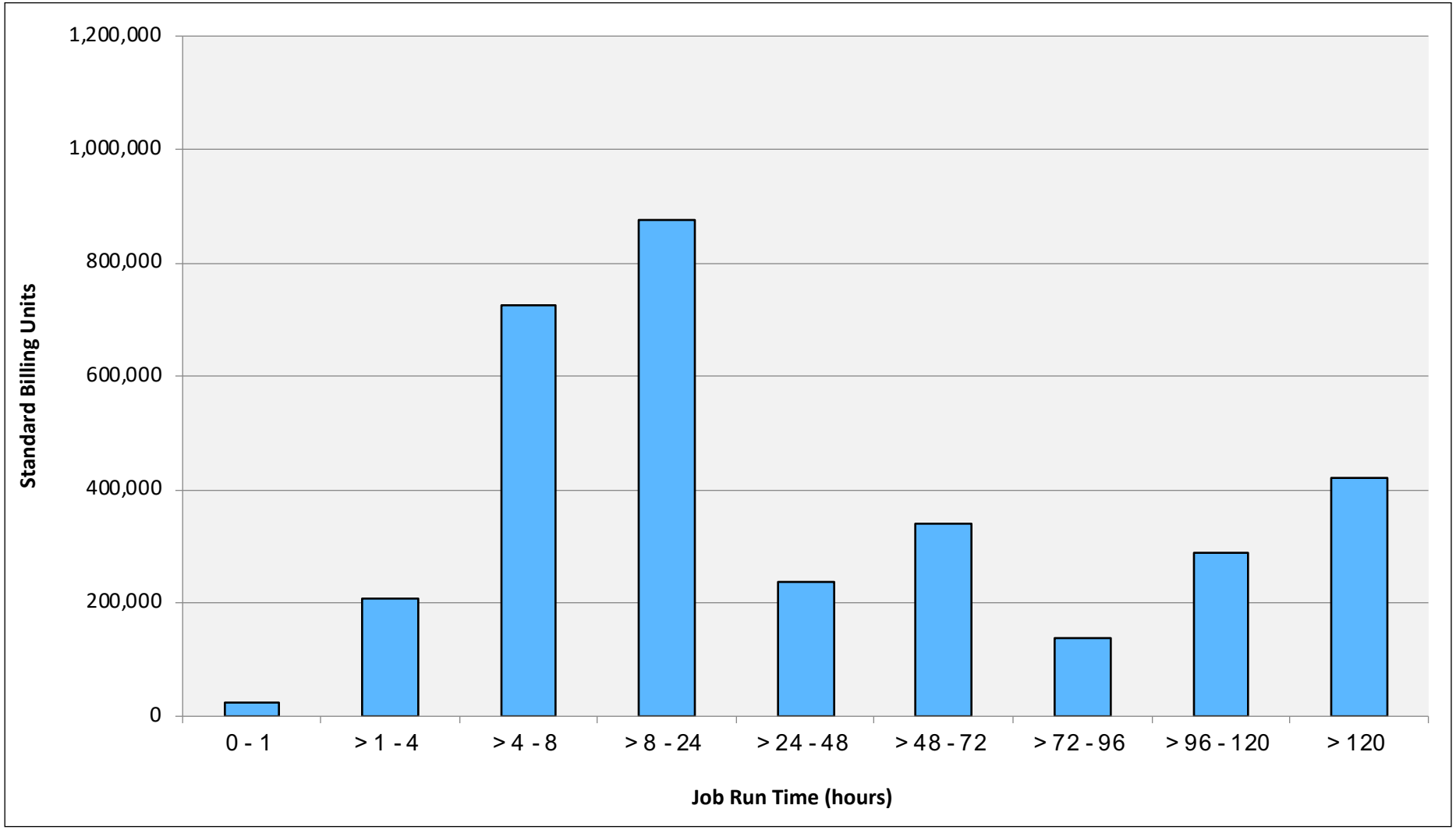
Electra: SBUs Reported, Normalized to 30-Day Month



Electra: Devel Queue Utilization



Electra: Monthly Utilization by Job Length



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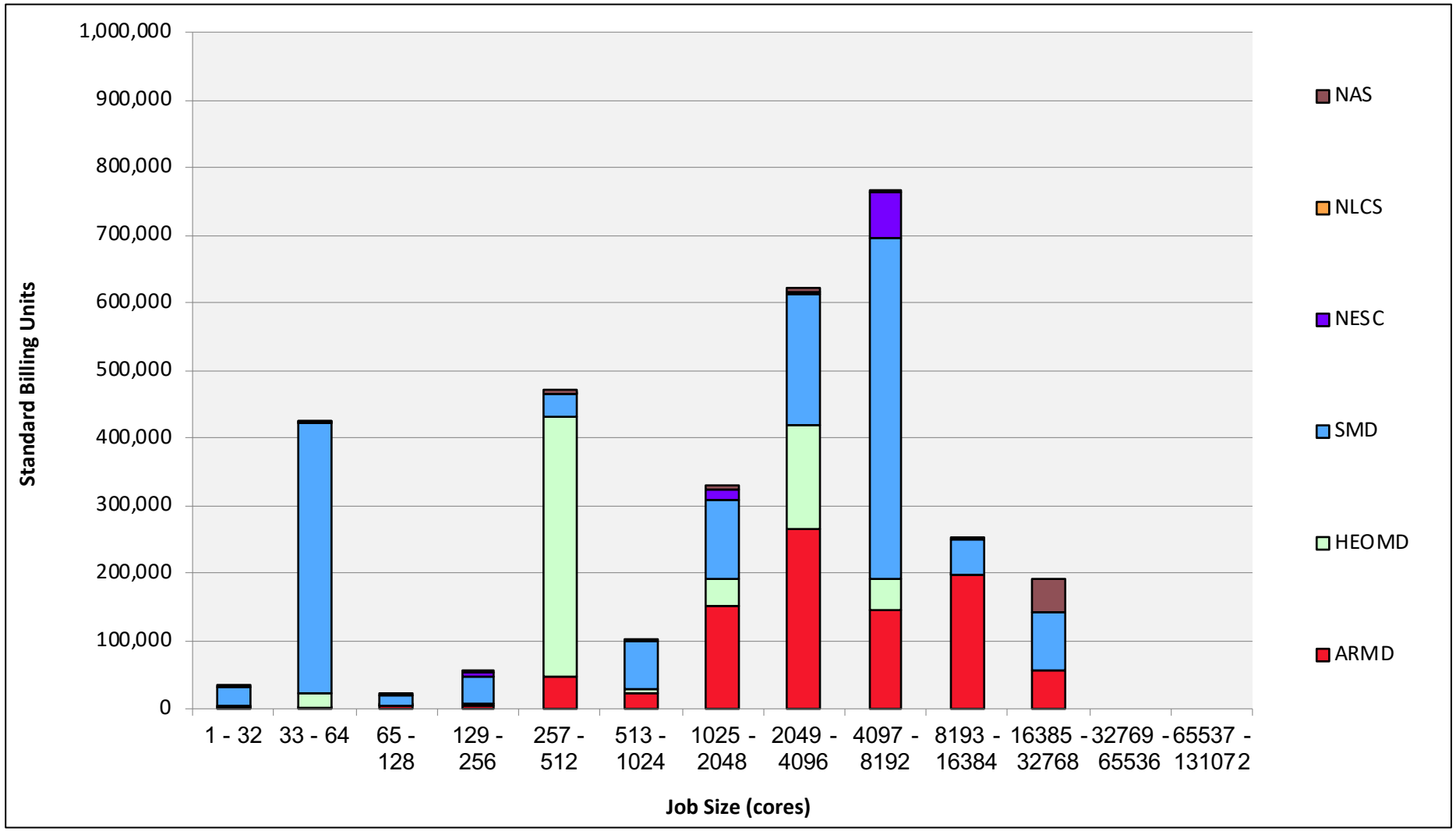
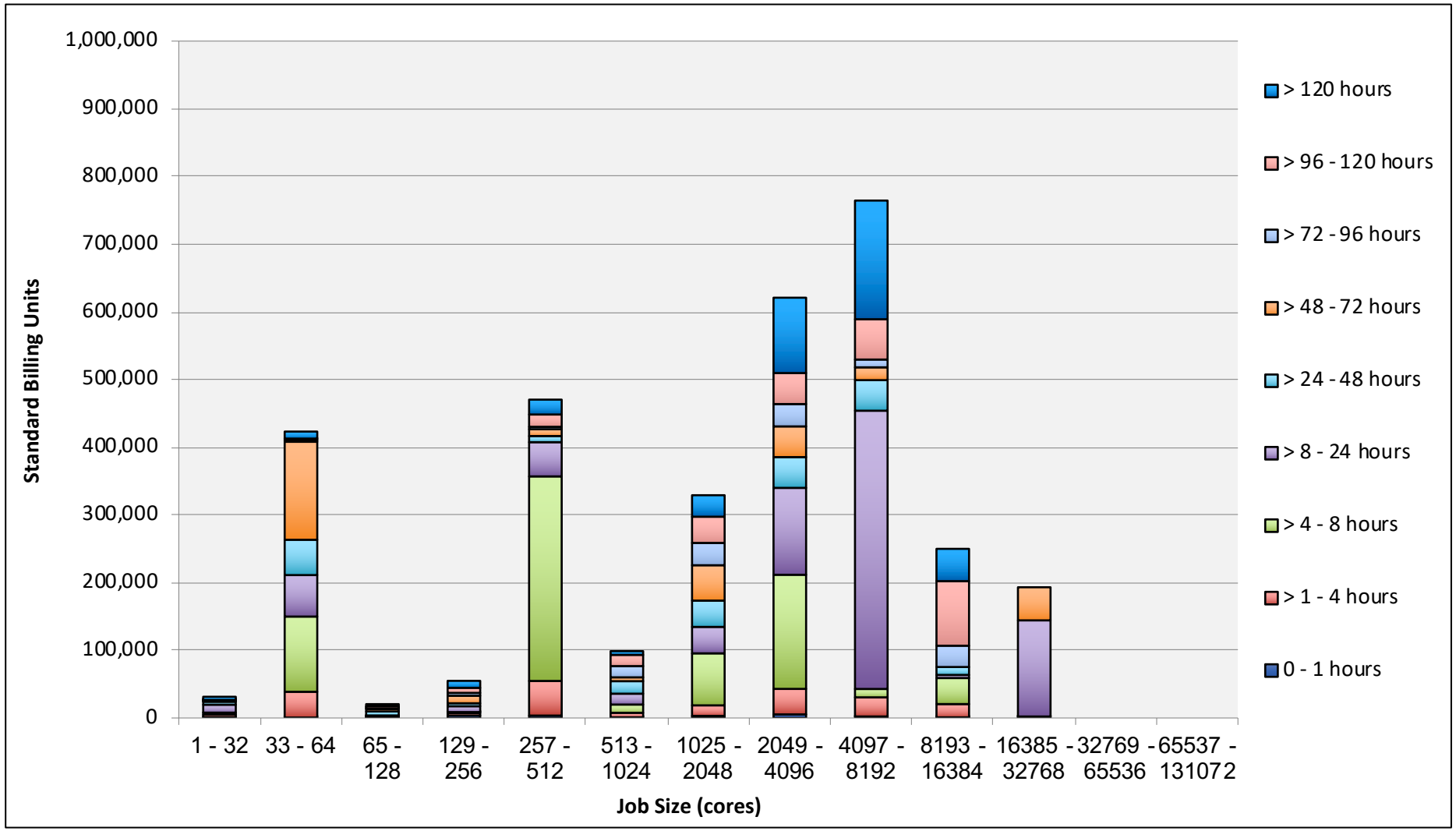
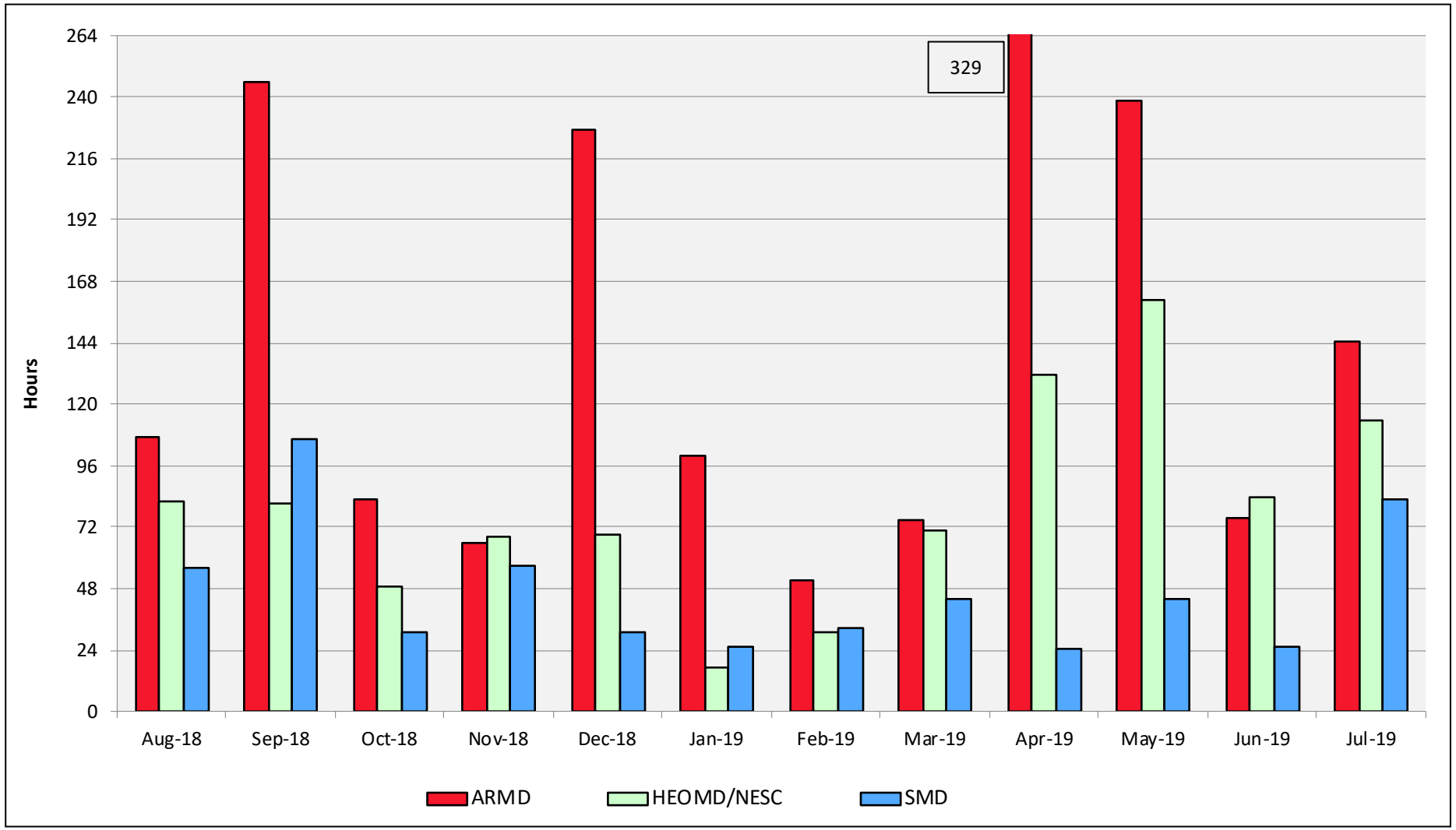


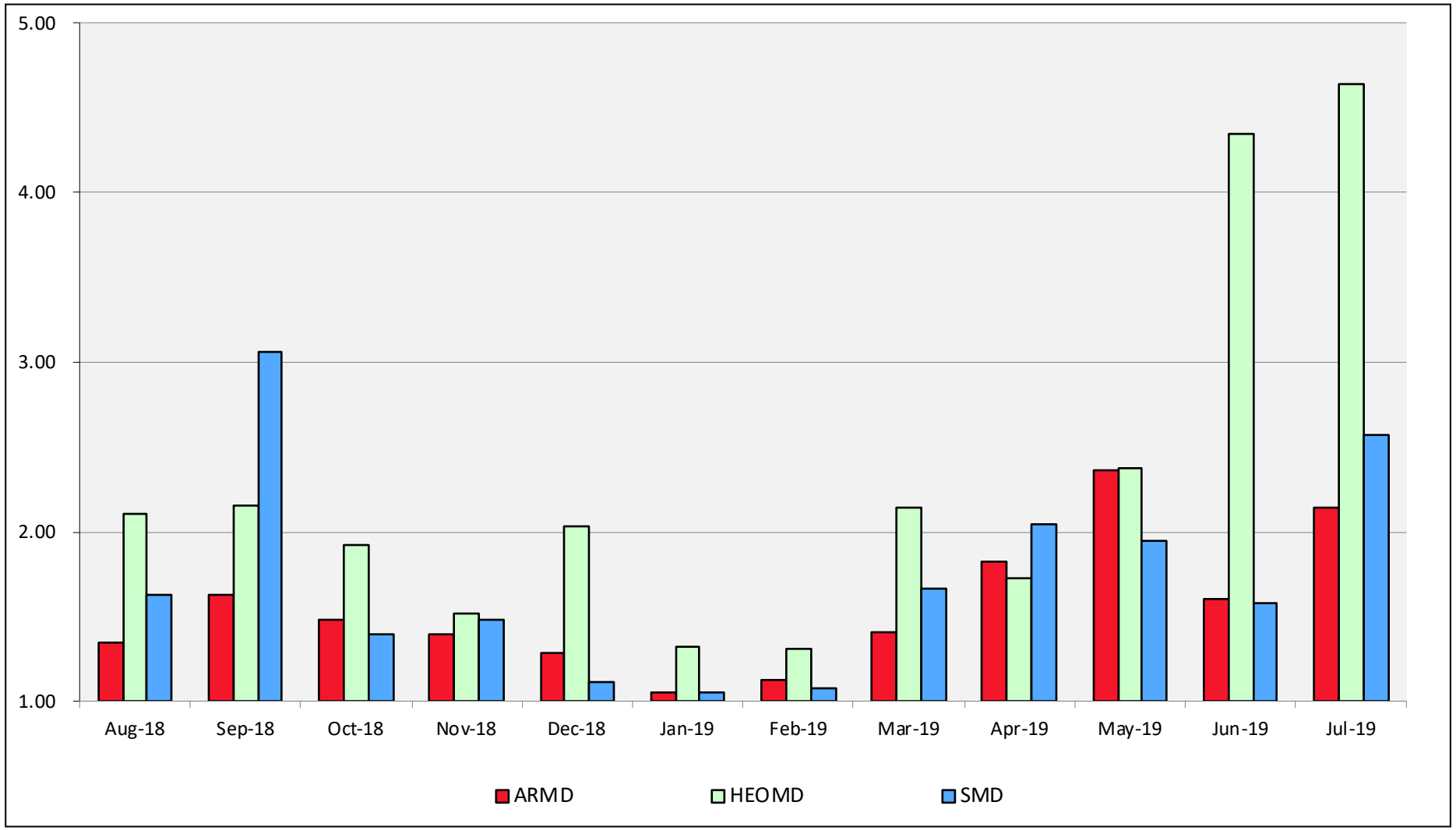
Electra: Monthly Utilization by Size and Length



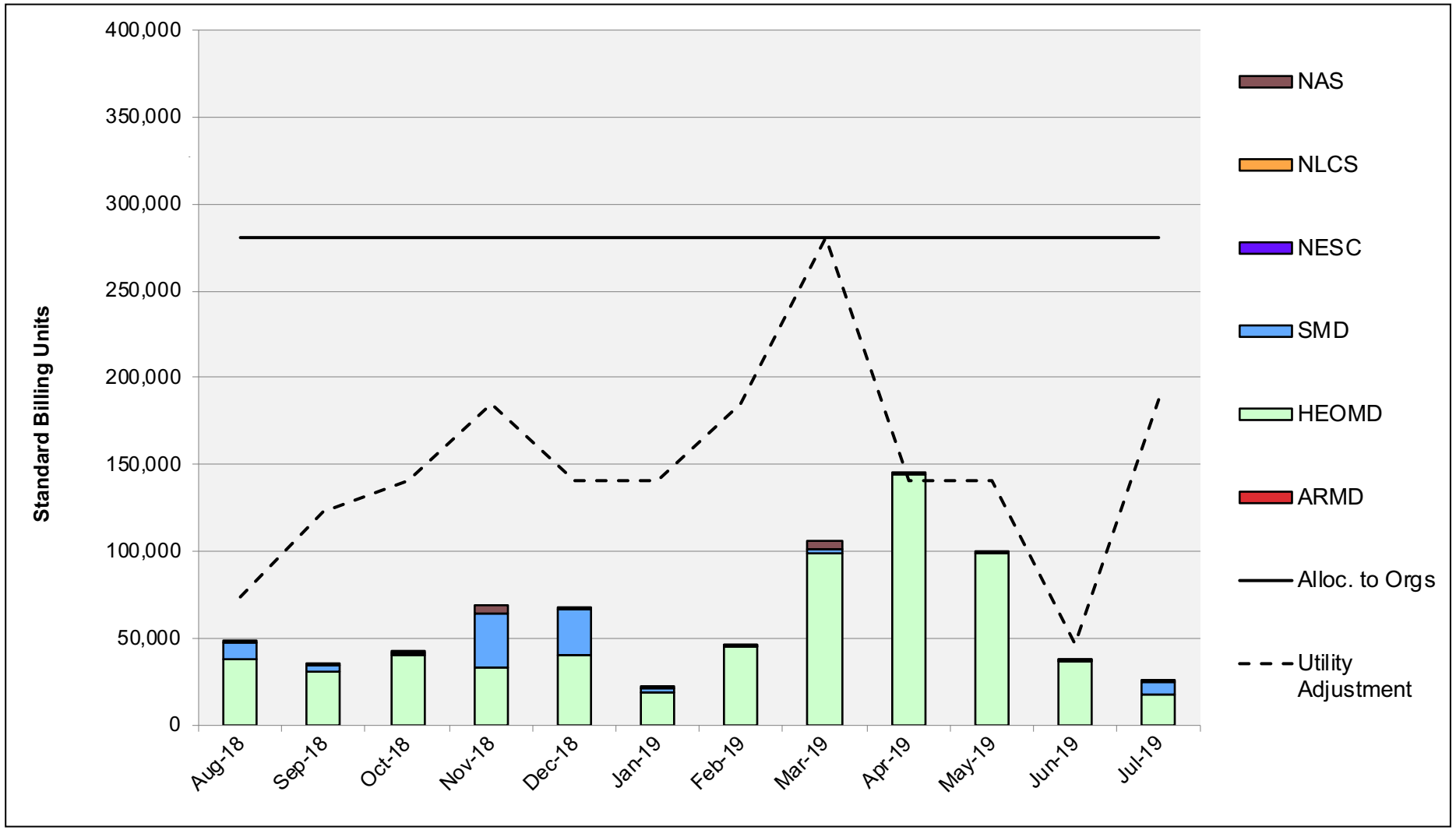
Electra: Average Time to Clear All Jobs



Electra: Average Expansion Factor



Merope: SBUs Reported, Normalized to 30-Day Month



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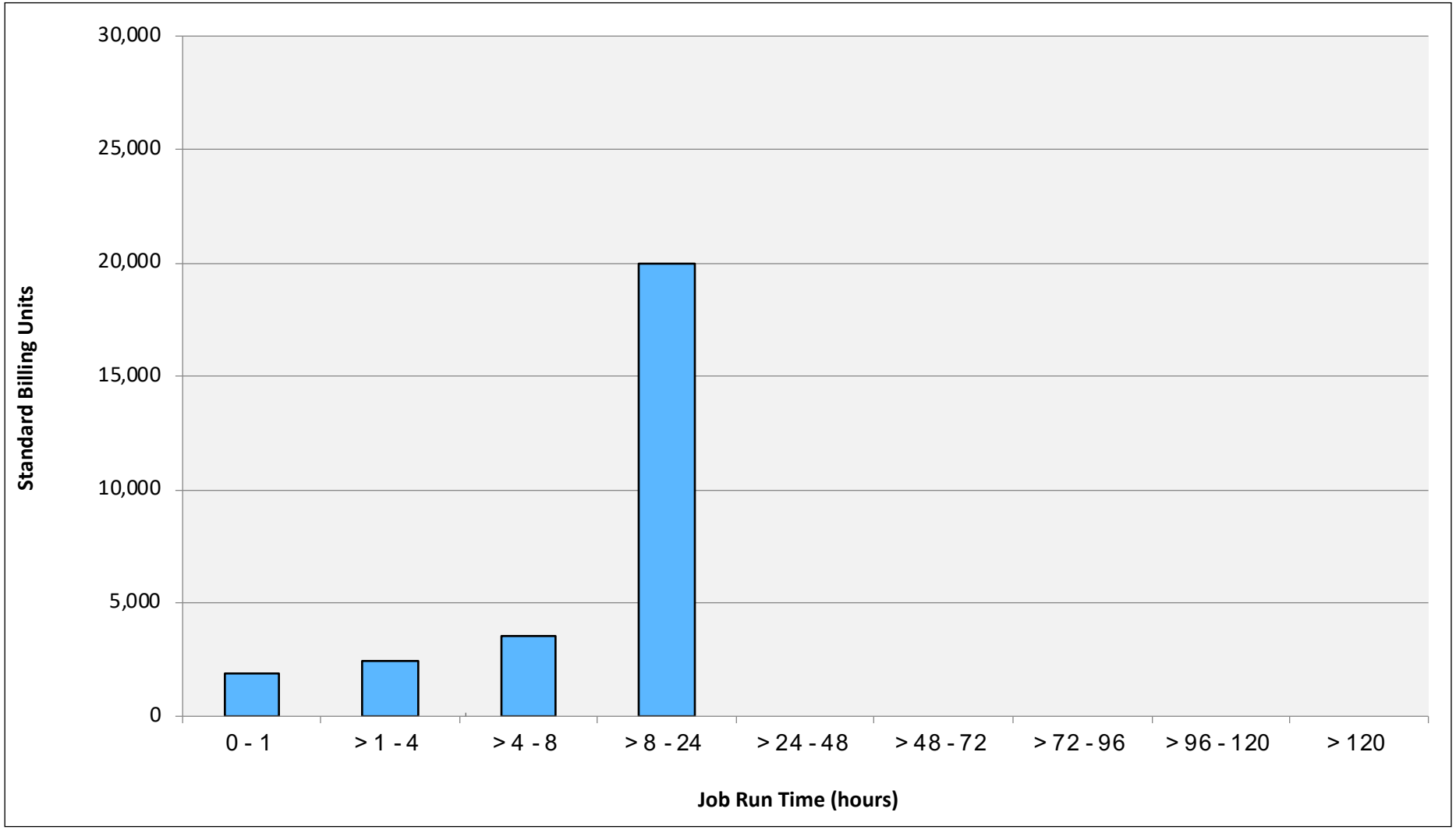
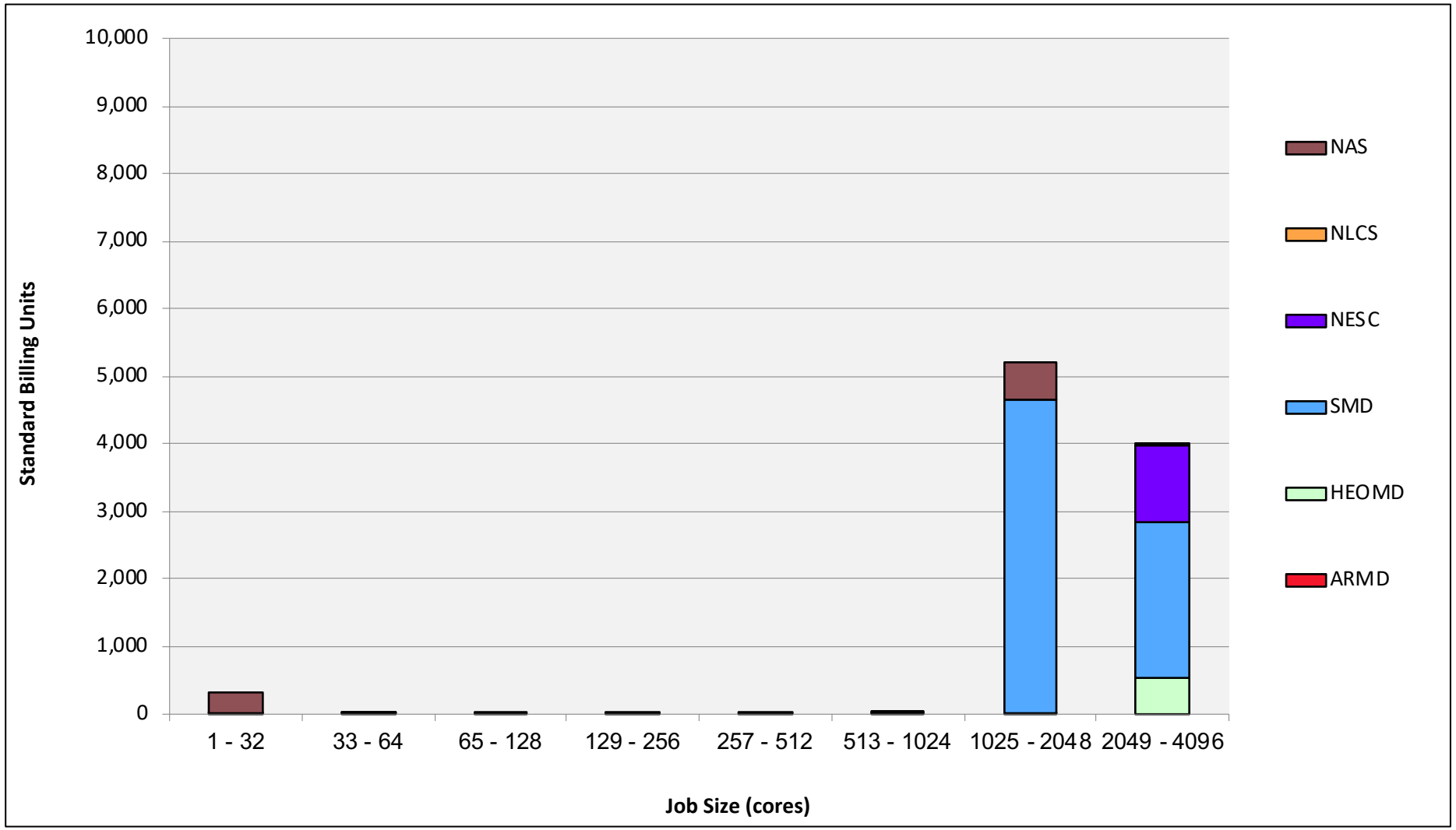
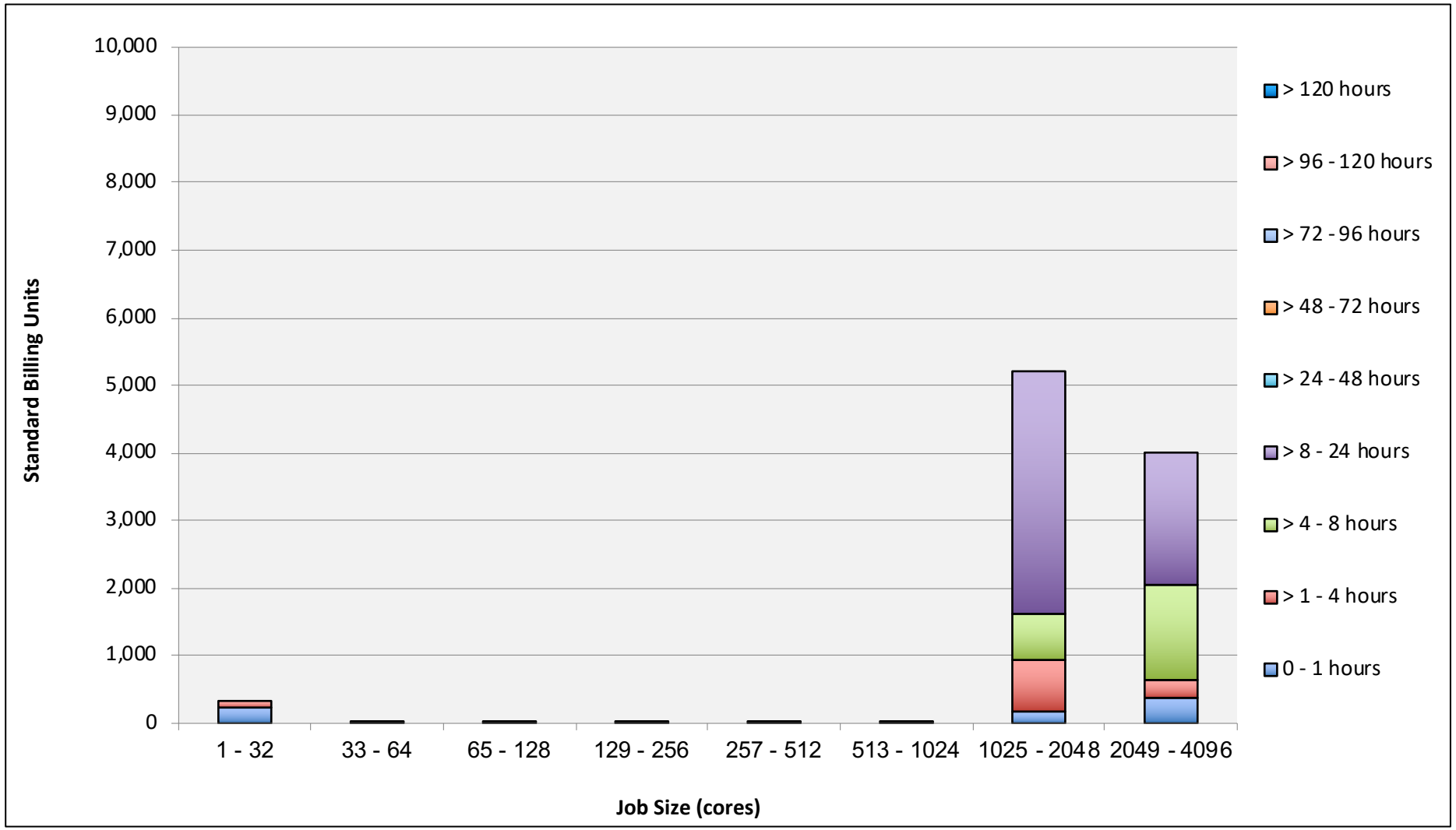


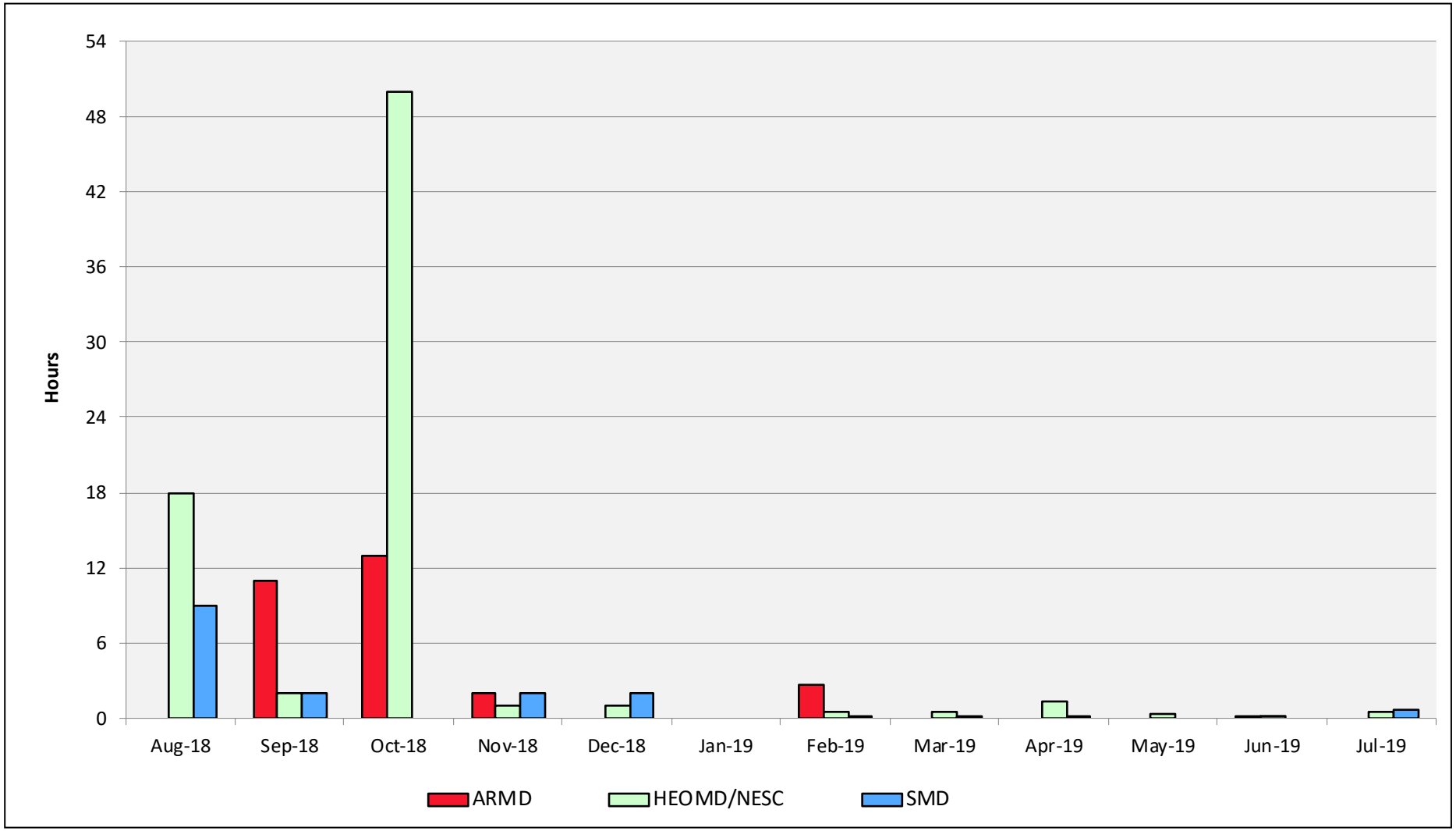
Merope: Monthly Utilization by Job Length



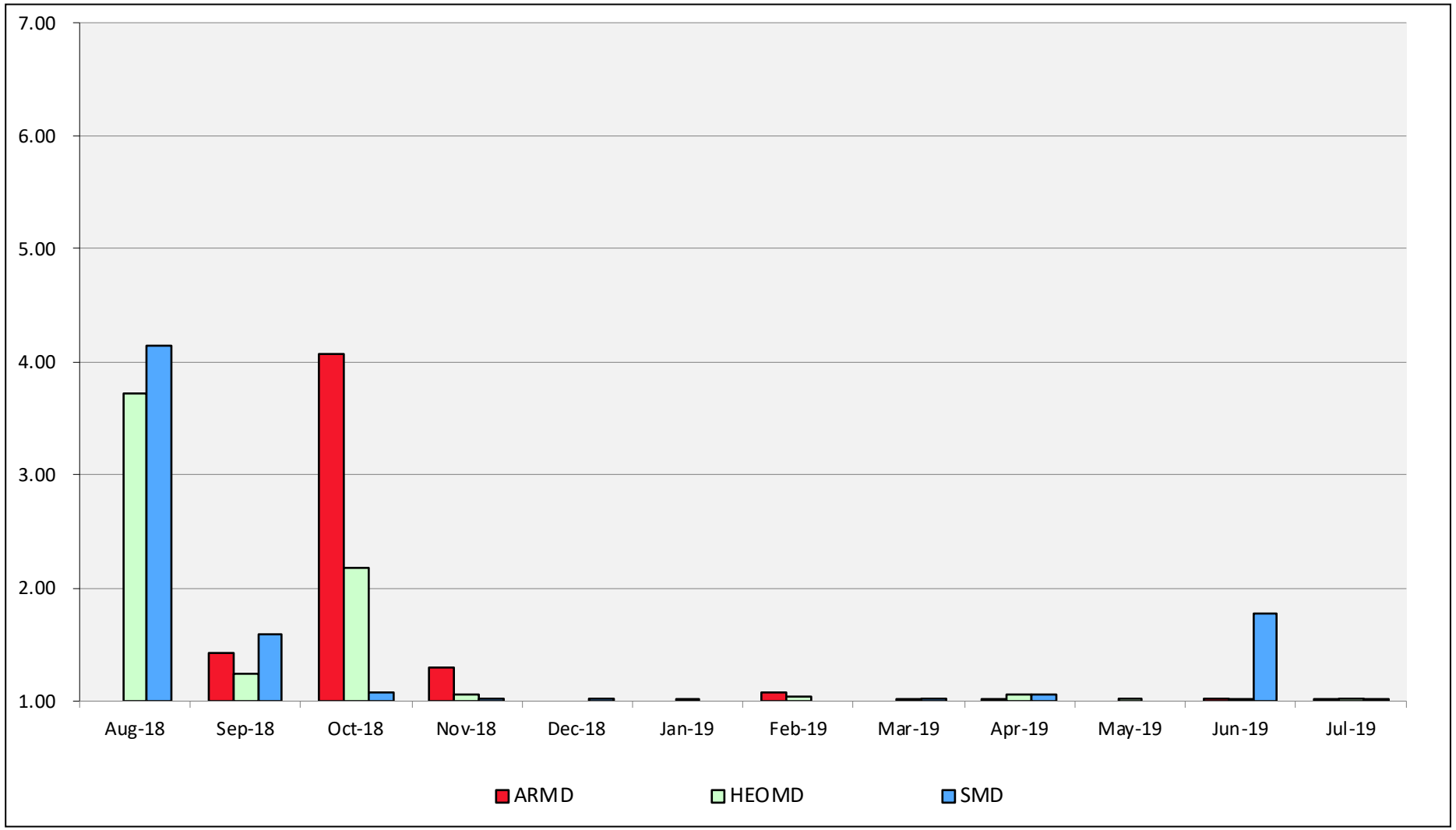
Merope: Monthly Utilization by Size and Length



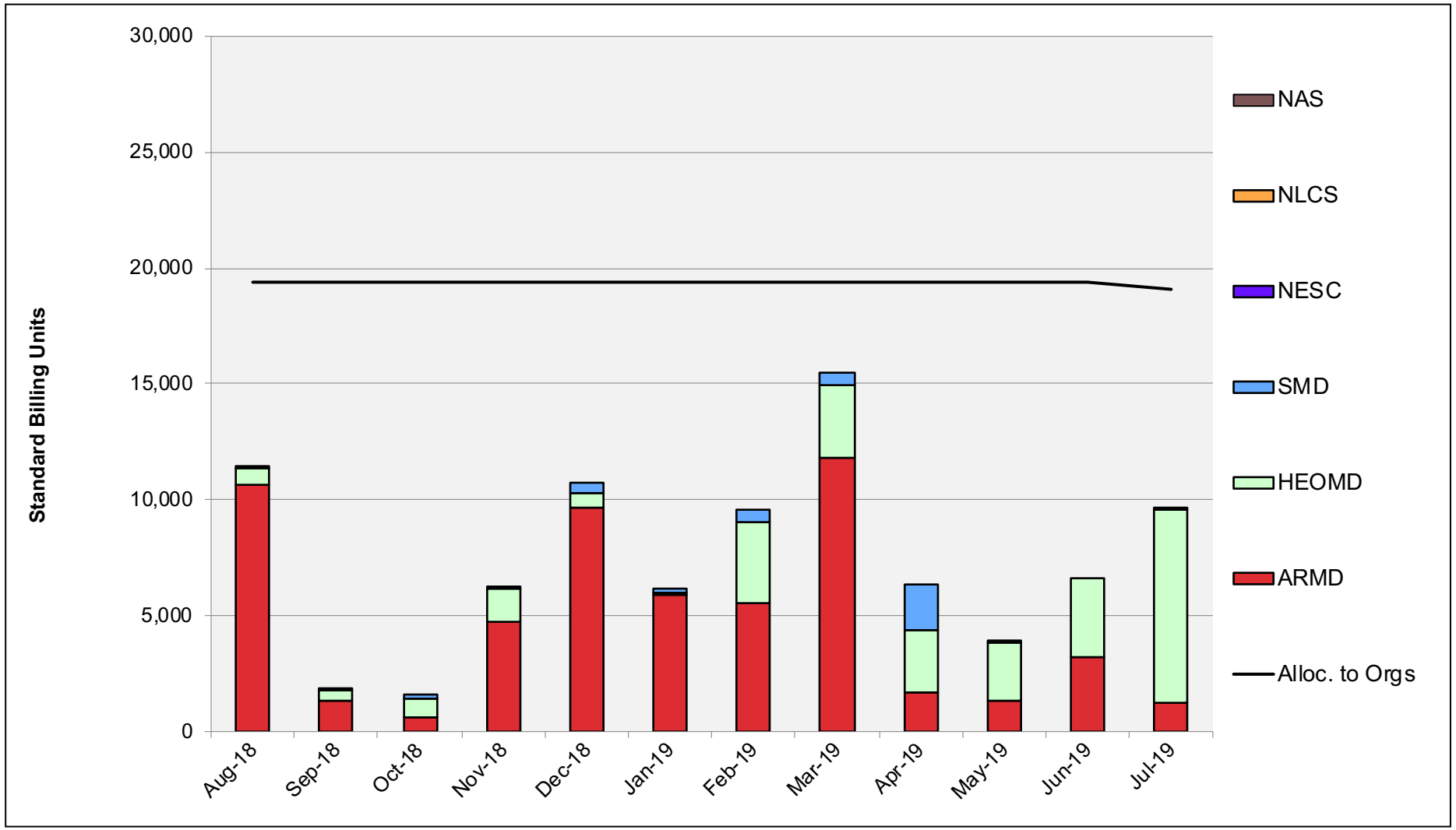
Merope: Average Time to Clear All Jobs



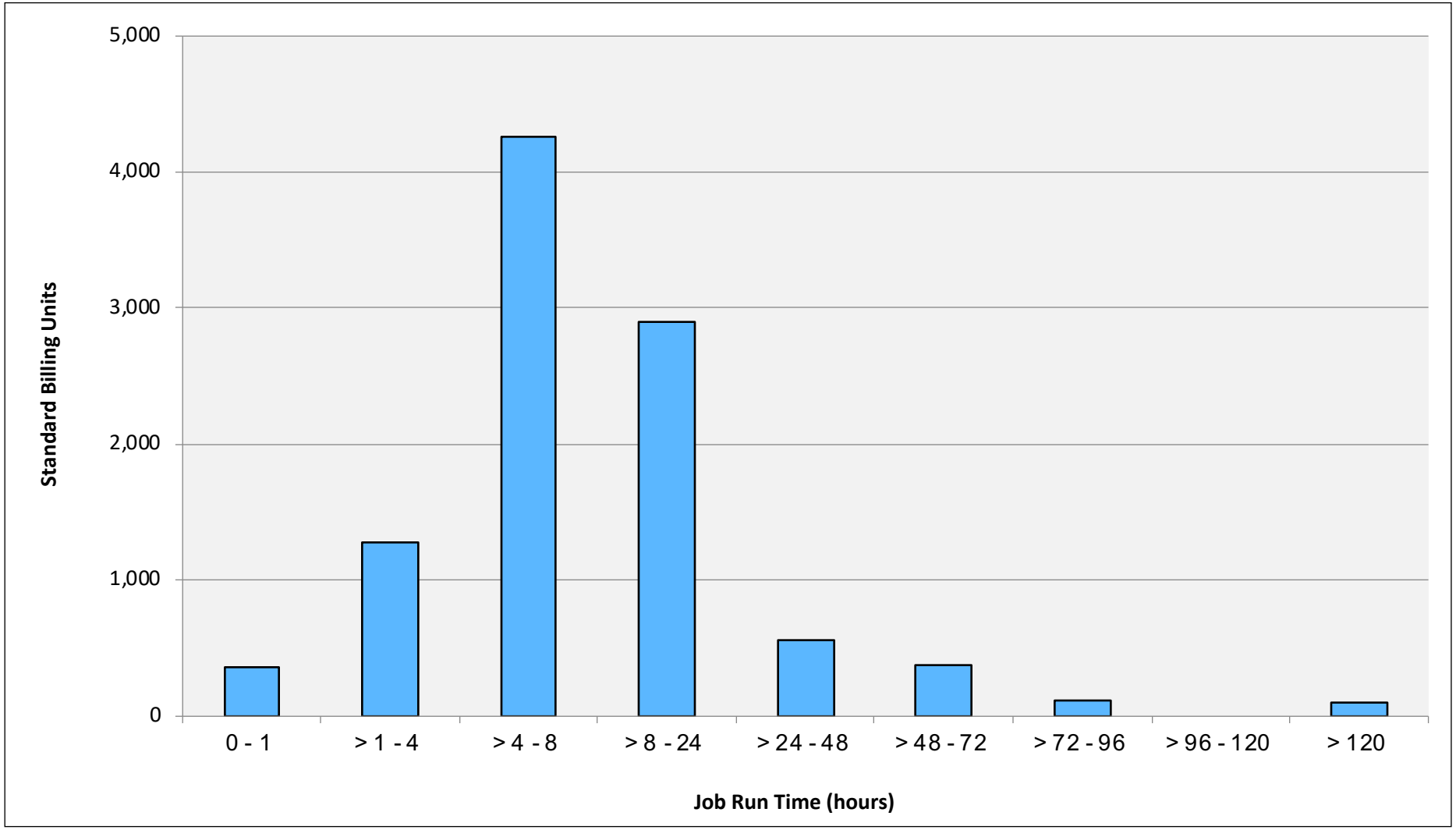
Merope: Average Expansion Factor



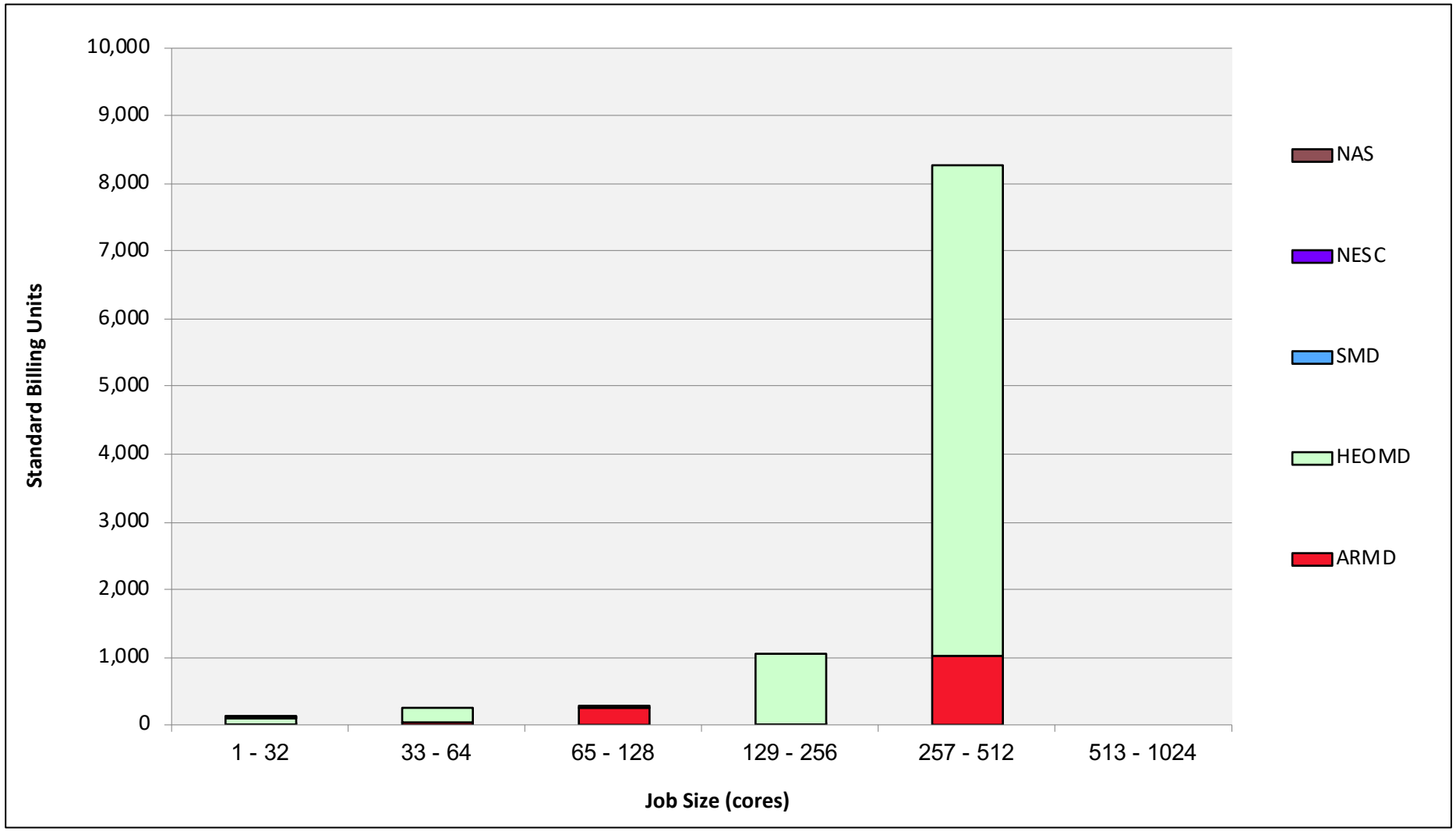
Endeavour: SBUs Reported, Normalized to 30-Day Month



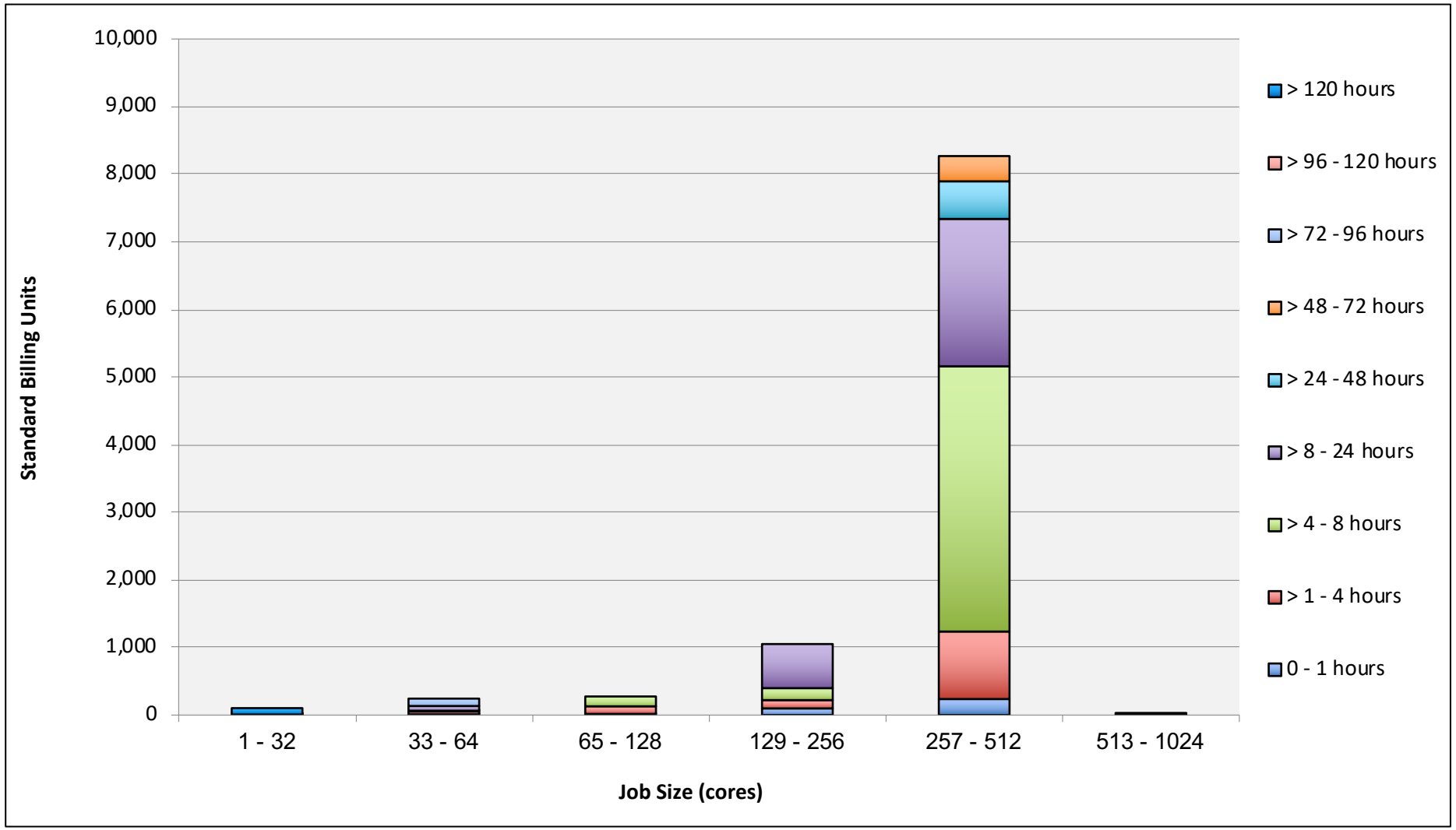
Endeavour: Monthly Utilization by Job Length



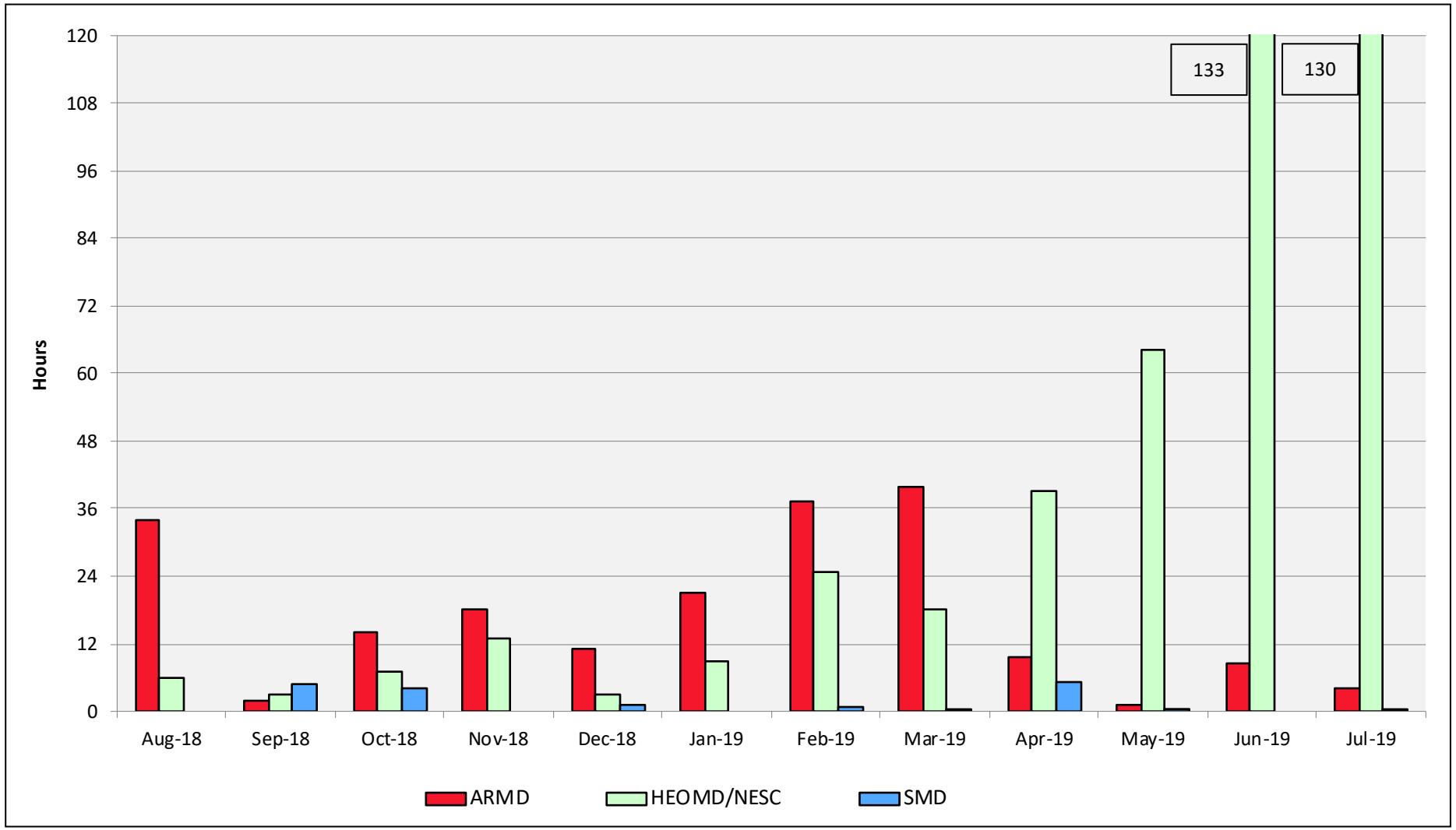
Endeavour: Monthly Utilization by Job Length



Endeavour: Monthly Utilization by Size and Length



Endeavour: Average Time to Clear All Jobs



Endeavour: Average Expansion Factor